NEW YORK FISH AND GAME JOURNAL

VOLUME 14 January, 1967 Number 1

SPECIES COMPOSITION, SIZE AND SEASONAL ABUNDANCE OF FISH IN THE SURF WATERS OF LONG ISLAND[1]

Richard H. Schaefer Conservation Biologist
New York State Conservation Department

ABSTRACT

A total of 67,918 fish representing 71 species were collected from the ocean surf at Fire Island, New York, between July 1 and November 30 in 1961, between May 1 and October 31 in 1962, and between May 1 and November 30 in 1963. This catch resulted from 188 sets of a 1,300-foot haul seine operated on 111 dates during the study period. The species composition of the catch each year, as well as size ranges and mean lengths for each species, are reported by month. The most abundant species (those which constituted 1 per cent or more of the total catch in any one year) are discussed individually, and monthly length-frequency distributions for each are presented.

Few researches have been conducted on the species composition, size distribution or seasonal abundance of fishes inhabiting the surf zone of outer, ocean-front beaches. The paucity of information on vertebrates characteristically associated with this environment was mentioned by Gunter (1958) and reiterated by McFarland (1963) in their respective studies of outer coastal beach fishes at Mustang Island, Texas. Indeed, the earlier author stated that the studies of Pearse *et al.* (1942) and Gunter (1945) were at that time "the only recent reports of seining studies of outside beaches from North America". Reid (1955, 1956), however, reported on the shallow-water fishes collected in June and early July along a seaward beach at Bolivar Peninsula on the northeastern Gulf coast of Texas. Although several ecological investigations of fish populations have been made since 1958, in which one or more sampling stations were situated on beaches exposed to the open ocean (Springer and Woodburn, 1960; Springer and McErlean, 1962; deSylva *et al.*, 1962), the studies by Carlisle *et al.* (1960) on the coast of southern California and by McFarland (1963) are apparently

[1] A contribution of Federal Aid in Fish and Wildlife Restoration Project F-15-R. The author wishes to thank those members of the Fish Research Unit at Oakdale, N. Y., who assisted in collecting the specimens. Special gratitude is extended to Irwin Alperin and Samuel Finkelstein who calculated much of the data on size and species composition, to Anthony Vaccaro who tabulated these data, and to Robert Kelsey who drafted the graphs.

the only additional published works in North America that specifically report on fish inhabiting ocean-surf environments.

Previous studies of marine fish populations in the vicinity of New York, like those conducted elsewhere, have not been primarily concerned with fish from ocean-surf environments. To the contrary, it would appear that this habitat has been avoided by most researchers, partly because of the difficulties encountered in sampling it. Greeley (1939), in summarizing extensive seining investigations of Long Island shore zones, reported only a few collections from surf areas along south shore outer beaches during July and August in 1938. Although little difficulty was experienced in collecting along north shore beaches bordering Long Island Sound and along exposed bay beaches at the eastern end of the Island where wave action was generally not severe, he stated that the "heavy surf made seining with fine mesh seines impossible on most days" at outer beach locations on the south shore. Gordon (1949) also studied the fish population of the shore zone at Coney Island (N. Y.) for an entire summer, but it would seem that this area could hardly be classified as a surf environment since Lower New York Harbor, although widely open to the Atlantic, is sheltered from it by Rockaway Point to the east and Sandy Hook to the south. Similarly, Warfel and Merriman (1944) made haul seine collections along a sandy beach in New Haven harbor on the Connecticut shore of Long Island Sound, but indicated that "the area is not directly exposed to the sea".

It is of interest that in all of the previously mentioned studies, except for the investigations by Carlisle *et al.* (1960) and McFarland (1963) in which haul seines of 140 feet and 633 feet (¾ inch stretch mesh) in length, respectively, were employed, the collecting gear used was relatively small in size and was, therefore, designed primarily to catch small fish. In most cases the seines ranged from 30 to 100 feet in length, and mesh sizes ranged from ⅛ to no larger than ¾ inch stretch. Moreover, most of these seines were operated in shallow water by wading without the use of either a seine boat for setting the net or additional warp for hauling it. The results of the earlier studies suggest that, using such gear and techniques, little opportunity was afforded to collect large and/or fast-swimming fish even if they were present in the environment.

The research presented here was prompted by the general lack of information specifically concerning fish populations inhabiting surf environments, especially in the western North Atlantic. So far as is known, this is one of the few scientific endeavors in which surf-zone fish were collected using gear of commercial proportions, and it is the first study focused on fish inhabiting outer beaches of the Atlantic coast north of North Carolina.

THE COLLECTING AREA

The collecting area constituted a stretch of outer barrier beach extending approximately 3½ miles east and 3½ miles west of Smith Point County Park on Great South Beach (commonly known as Fire Island) off the south shore of Long Island. Great South Beach itself extends from Fire Island Inlet approximately 32 miles eastward to Moriches Inlet. It is fully exposed to the open Atlantic to the south and is isolated from the mainland by Great South, Bellport, Narrow and Moriches Bays to the north.

The area, of which the geology, topography and ecology have been described in some detail by Snyder (1963), was generally characterized by a fairly broad, sandy shoreline to seaward and an adjacent series of high, vegetation-covered sand dunes to landward (Figure 1). Except for the jetties in the inlet areas, there were no rock groins anywhere along the entire expanse of beach to shelter it from the full effects of the longshore currents and pounding surf. Indeed, the waves generally ran 2 to 4 feet in height, but waves as high as 10 feet or more have been reported (Helle, 1958). As a result of these forces and others, both the submarine and terrestrial topography of the beach had been and was at the time of this study in a constant state of flux, as indicated by an almost daily variation in the locations of submerged bars and troughs, shoreline cusps and rip currents.

METHODS AND MATERIALS

Collecting of surf-zone fishes was conducted between July 1 and November 30 in 1961, between May 1 and October 31 in 1962, and between May 1 and November 30 in 1963. Although November in 1962 was within the scheduled sampling period, seining was precluded by inclement weather and sea conditions. The sampling gear used was a modified 1,300 by 12½-foot commercial nylon beach seine of the following specifications: outer wings, each 550 feet long and comprised of 6-thread, 3-inch stretch webbing; inner wings or bunt, each 90 feet long and comprised of 12-thread, 2-inch stretch webbing; bag or "cod end", 25 feet deep and comprised of 15-thread, 1½-inch stretch webbing with a mouth 20 feet wide. To aid in the initial stages of hauling the net, 300 feet of 7/16-inch warp was fastened to the bridle at each brail. With this net and a 21-foot Hiram Lowell banks dory, which was towed to the seining site on a 21-foot flat-bed trailer behind a 4-wheel-drive Jeep (Figure 2), seining operations were conducted on a daily (weekday) schedule unless prevented by unfavorable weather or surf conditions. Usually, only one or two, and rarely three, seine hauls could be made in one day.

Daily seining sites along the beach were arbitrarily selected by the field crew. Determining factors were the degree of beach slope at the

Figure 1. View of collecting area on Great South Beach looking westward from Smith Point County Park.

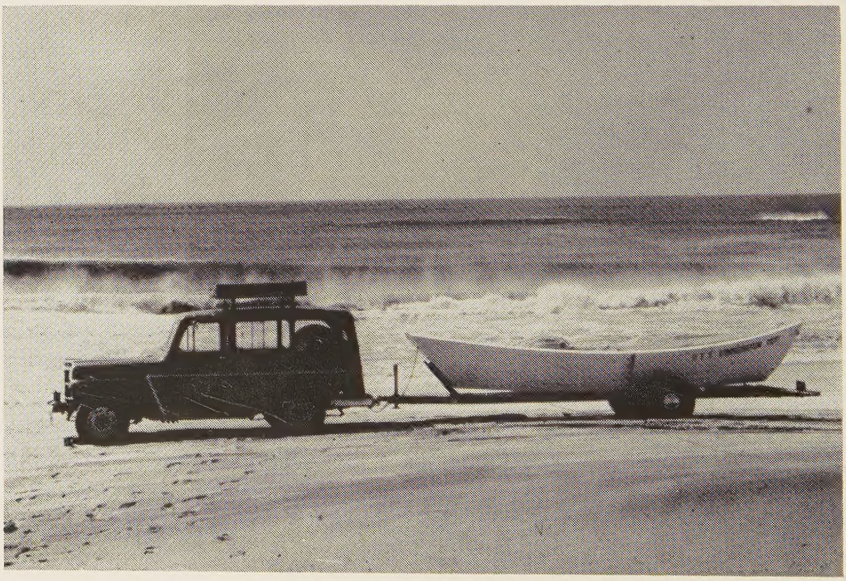


Figure 2. Equipment used in seining operations, including 4-wheel-drive vehicle, flat-bed boat trailer and surf dory with haul seine piled in stern.

water line, the height of waves, the visible strength of rips and currents, and the presence or absence of submerged bars, troughs, holes or obstructions as indicated by surface water movements. In other words, the seining sites were chosen with the primary considerations being the safety and physical capabilities of the field crew, which varied from four to six personnel, and prevention of the escape of trapped fish under or over the net.

Having determined the seining site, the dory, with the net piled in the stern, was removed from the trailer and launched into the surf. The boat, usually crewed by two oarsmen and a net handler-boat captain in the stern, was rowed directly offshore for a distance of approximately 250 to 550 feet, then parallel to the shore in the direction of the prevailing longshore current for approximately another 800 feet, and then directly back inshore again while the net and warp were payed out over the stern. The seine and warp, having been set, encompassed an area, roughly rectangular in shape, which ranged from a minimum of about 200,000 square feet or 4.6 surface acres to a maximum of about 440,000 square feet or 10.1 surface acres.

During 1961 the seine was hauled entirely by hand, but in 1962 and 1963 the operation was aided by a direct drive winch (Ramsey Model C7R capstan) mounted on the front end of the Jeep. Both wings of the net were hauled simultaneously, one by hand and the other by winch, the objective being to keep the bag centered midway

Figure 3. Seining crew engaged in identifying, sorting and enumerating a catch.

between the wings at all times. Once the wings were on the beach and the webbing of the bunt was reached, the seine was hauled entirely by hand until the bag was brought ashore. The length of time needed for a single set, i.e., from launching the dory to beaching the bag, varied with the condition of the sea and the size of the field crew present, but it was usually about 30 to 45 minutes.

When the bag had been beached, the fish in it were transferred by scap net to areas higher up the beach away from the surf. There, specimens were sorted by species, enumerated and measured to the nearest 5 millimeters in length on a standard millimeter measuring board (Figure 3). Those species having forked caudal fins were measured to fork length; all others were measured to total length. In cases where a particular species was captured in great abundance, the total number was estimated and a sample (usually about 100) was randomly selected to be measured.

Except for striped bass and smooth dogfish which were assigned to 25-millimeter size classes, all specimens were recorded according to 10-millimeter size classes. From these data monthly and annual percentage frequencies of occurrence by size were calculated, as well as size ranges and mean lengths for each species. Monthly length-frequency distributions are presented here for only the 15 most abundant species.

Water temperature (in degrees Fahrenheit) and salinity (in parts per thousand) measurements were made 1 foot below the water surface just prior to each set of the net using a Gemware salinity hydrometer kit (No. 1110/3) and a copper hydrometer jar (No. 1115) with thermometer.

WATER TEMPERATURE AND SALINITY

Water temperature and salinity observations made on the collecting dates are presented in Table 1 and in Figure 4. Water temperatures seldom exceeded 70° F. or fell below 50° F., and salinities seldom exceeded 33 0/00 or fell below 29 0/00 during the study period.

EFFORT AND CATCH

During the study, 188 seine hauls were made on 111 dates: 66 on 26 dates in 1961, 55 on 38 dates in 1962, and 67 on 47 dates in 1963. Since the water temperature was recorded just prior to each haul, the number of hauls made on any particular date is equal to the number of temperature readings for that date as indicated in Table 1. The catch and number of species represented each year are given in Table 2.

SPECIES AND SIZE COMPOSITION

The different species taken, together with the scientific name of each, are listed in Table 3. The monthly and total species composition

TABLE 1. WATER TEMPERATURE AND SALINITY DATA COLLECTED IN 1961, 1962 AND 1963*

Date		Water temperature (degrees F.)	Salinity (parts per thousand)
		1961	
July	17	69.0	29.2
	18	70.0	29.3
	24	70.0§	29.0§
	27	66.5§	29.9§
	28	69.3†	29.2†
	Mean	69.0	29.3
August	14	64.7†	30.2†
	15	67.0†	30.2†
	18	69.0†	29.3†
	23	69.0†	29.9†
	24	70.3†	29.3†
	25	72.3†	28.5†
	30	62.7†	30.9†
	Mean	67.9	29.7
September	1	65.3†	30.6†
	27	67.0	30.3
	28	67.0†	30.3†
	29	64.0†	30.8†
	Mean	65.8	30.5
October	9	65.0†	30.7†
	10	65.3†	31.1†
	11	65.0	31.2
	16	58.3†	32.4†
	17	58.0†	32.2†
	19	61.8†	31.2†
	Mean	62.2	31.5
November	7	58.0	32.2
	16	54.7†	32.8†
	22	49.3†	33.3†
	30	45.0†	33.6†
	Mean	51.8	33.0
		1962	
May	8	47.0§	..
	9	48.0	..
	10	52.0	..
	11	50.0§	..
	22	61.0§	..
	23	60.0§	31.6§
	28	56.0	31.8
	Mean	53.4	31.7

Table 1. *(continued)*

Date		Water temperature (degrees F.)	Salinity (parts per thousand)
June	4	58.0§	31.2§
	7	60.5§	30.8§
	8	59.0§	31.1§
	18	62.0	30.8
	26	66.0	30.3
	27	66.0	30.4
	28	66.5§	29.9§
	Mean	62.6	30.6
July	5	66.0	31.1
	6	67.5§	29.8§
	19	71.0	28.8
	20	70.5§	29.3§
	25	68.0	29.6
	26	65.0	29.4
	30	63.0	30.2
	31	69.0	30.1
	Mean	67.5	29.8
August	2	68.0	29.8
	3	70.5§	29.6§
	17	70.0	29.6
	22	64.0	31.4
	23	64.0	30.4
	27	73.0	29.3
	30	70.7†	29.8†
	31	71.0	29.7
	Mean	68.9	30.0
September	6	67.0	30.1
	7	67.0§	30.9§
	20	57.5§	32.15§
	Mean	63.8	31.1
October	2	63.0§	31.0§
	4	63.0	31.8
	15	59.0	. .
	18	60.0	31.2
	25	55.5§	32.15§
	Mean	60.1	31.5
		1963	
May	6	50.0	33.3
	7	52.0	33.2
	13	52.0	. .
	16	54.0§	32.8§
	17	55.0	32.2
	21	54.0	32.0
	22	55.0	32.0
	23	50.0	32.8
	27	57.0	32.0
	Mean	53.2	32.5

TABLE 1. *(continued)*

Date		Water temperature (degrees F.)	Salinity (parts per thousand)
June	11	61.0	30.7
	12	61.0	30.8
	13	54.0	..
	14	56.0	..
	17	61.0§	..
	18	59.5§	..
	19	60.0§	..
	20	60.0	31.0
	21	56.0	31.2
	24	57.0§	31.5§
	25	59.0§	31.3§
	26	57.0	31.6
	27	62.5§	31.05§
	Mean	58.8	31.1
July	9	63.0§	31.5§
	10	62.5§	31.7§
	17	65.0§	31.35§
	24	68.0	29.4
	25	68.5§	32.2§
	26	68.0§	31.1§
	Mean	65.8	31.2
August	5	66.0§	31.7§
	6	63.0§	32.05§
	7	63.5§	31.6§
	12	71.0§	31.5§
	15	58.5§	32.7§
	19	64.0§	31.75§
	21	67.0	31.3
	22	68.0	31.2
	Mean	65.1	31.7
September	10	66.0	32.0
	Mean	66.0	32.0
October	9	58.0	32.8
	10	60.0	32.0
	14	58.5§	32.3§
	15	59.0	31.8
	16	59.0	32.0
	17	60.0	31.6
	Mean	59.1	32.1
November	15	50.0	32.8
	20	51.5§	32.6§
	21	52.0	..
	22	52.0	..
	Mean	51.4	32.7

* All measurements made 1 foot below surface of water.
§ Average of two observations.
† Average of three observations.

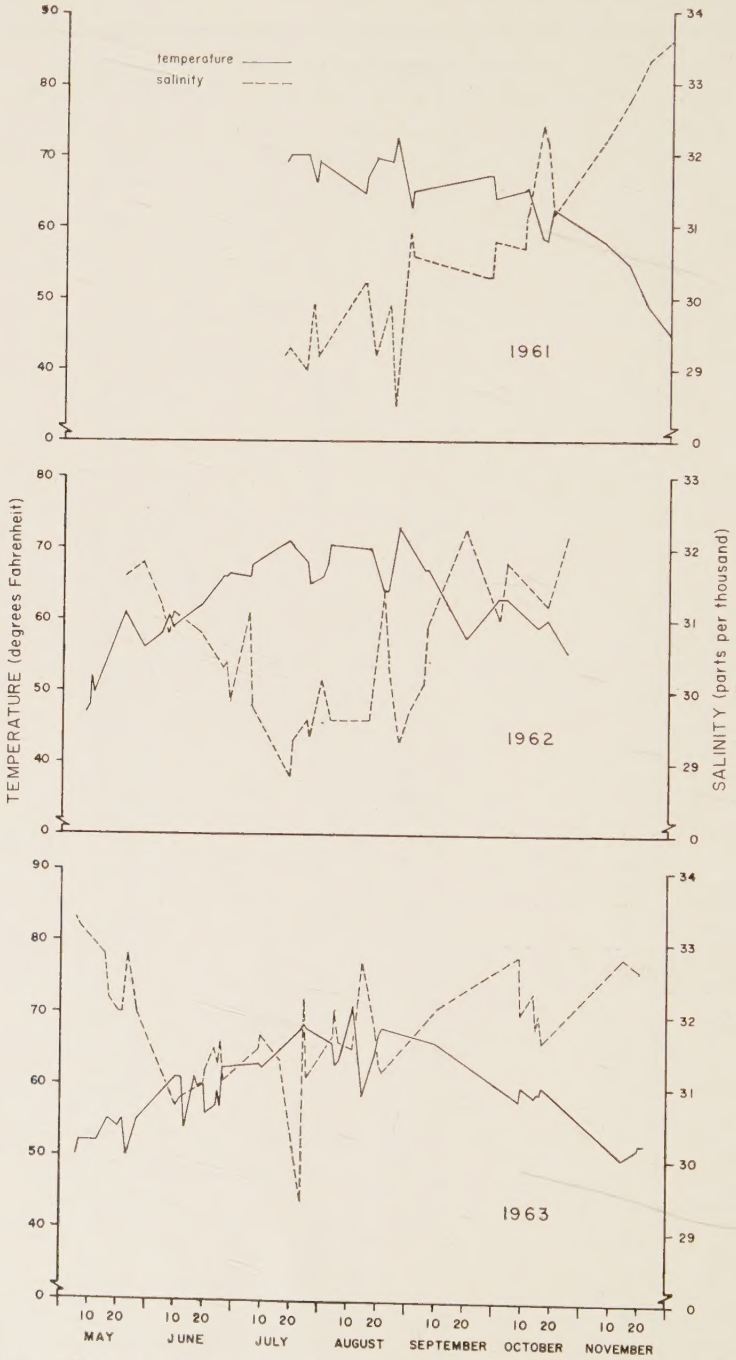


Figure 4. Variations in water temperature and salinity as recorded on the dates when seining was done in 1961, 1962 and 1963.

TABLE 2. CATCH AND NUMBER OF SPECIES REPRESENTED EACH YEAR

Year	Catch		Species represented
	Total number	Number per haul	
1961	5,076	77	40
1962	24,437	444	56
1963	38,405	573	50
Total	67,918	361	71

TABLE 3. SPECIES OF FISH TAKEN AND SCIENTIFIC NAME OF EACH

Common name	Scientific name
African pompano	*Alectis crinitus*
Alewife	*Alosa pseudoharengus*
American shad	*Alosa sapidissima*
Atlantic bonito	*Sarda sarda*
Atlantic croaker	*Micropogon undulatus*
Atlantic cutlassfish	*Trichiurus lepturus*
Atlantic herring	*Clupea harengus harengus*
Atlantic mackerel	*Scomber scombrus*
Atlantic menhaden	*Brevoortia tyrannus*
Atlantic moonfish	*Vomer setapinnis*
Atlantic needlefish	*Strongylura marina*
Atlantic round herring	*Etrumeus sadina*
Atlantic silverside	*Menidia menidia*
Atlantic sturgeon	*Acipenser oxyrhynchus*
Banded rudderfish	*Seriola zonata*
Bay anchovy	*Anchoa mitchilli*
Bigeye scad	*Selar crumenophthalmus*
Blueback herring	*Alosa aestivalis*
Bluefish	*Pomatomus saltatrix*
Blue runner	*Caranx crysos*
Butterfish	*Poronotus triacanthus*
Clearnose skate	*Raja eglanteria*
Cornet fish	*Fistularia tabacaria*
Cownose ray	*Rhinoptera bonasus*
Crevalle jack	*Caranx hippos*
Cunner	*Tautoglabrus adspersus*
Dusky shark	*Carcharinus obscurus*
Goosefish	*Lophius americanus*
Grubby	*Myoxocephalus aeneus*
Hickory shad	*Alosa mediocris*
Leatherjacket	*Oligoplites saurus*
Little skate	*Raja erinacea*
Longhorn sculpin	*Myoxocephalus octodecemspinosus*
Lookdown	*Selene vomer*
Mackerel scad	*Decapterus macarellus*
Northern kingfish	*Menticirrhus saxatilis*
Northern pipefish	*Syngnathus fuscus*
Northern puffer	*Sphaeroides maculatus*

Table 3. *(continued)*

Common name	Scientific name
Northern searobin	*Prionotus carolinus*
Northern sennet	*Sphyraena borealis*
Orange filefish	*Alutera schoepfi*
Oyster toadfish	*Opsanus tau*
Planehead filefish	*Monacanthus hispidus*
Pompano	*Trachinotus carolinus*
Rough scad	*Trachurus lathami*
Roughtail stingray	*Dasyatis centroura*
Round scad	*Decapterus punctatus*
Sand shark	*Carcharius taurus*
Sandbar shark	*Carcharinus milberti*
Scup	*Stenotomus chrysops*
Shortnose sturgeon	*Acipenser brevirostrum*
Silver hake	*Merluccius bilinearis*
Silver perch	*Bairdiella chrysura*
Smooth dogfish	*Mustelis canis*
Smooth puffer	*Lagocephalus laevigatus*
Spiny dogfish	*Squalus acanthias*
Spot	*Leiostomus xanthurus*
Spotted seahorse	*Hippocampus erectus*
Squirrel hake	*Urophycis chuss*
Striped bass	*Roccus saxatilis*
Striped burrfish	*Chilomycterus schoepfi*
Striped mullet	*Mugil cephalus*
Striped searobin	*Prionotus evolans*
Summer flounder	*Paralichthys dentatus*
Tautog	*Tautoga onitis*
Weakfish	*Cynoscion regalis*
White mullet	*Mugil curema*
White perch	*Roccus americanus*
Windowpane	*Scophthalmus aquosus*
Winter flounder	*Pseudopleuronectes americanus*
Winter skate	*Raja ocellata*

of the catch for each year, as well as summarized information on size range and mean length for each species are presented in Tables 4, 5 and 6. In each case, the species are listed in order of descending abundance for the total year's catch. Fewer than 10 species comprised more than 90 per cent of the catch each year. The most abundant (those which constituted 1 per cent or more of the total catch in any one year) were six species of herring (Clupeidae)—the alewife, American shad, Atlantic herring, Atlantic menhaden, blueback herring and hickory shad—and the butterfish, bluefish, northern kingfish, northern puffer, smooth dogfish, striped bass, striped searobin, striped mullet and windowpane. Observations on the size and seasonal abundance of these species are reported separately.

TABLE 4. MONTHLY SPECIES AND SIZE COMPOSITION OF THE CATCH IN 1961

Species	Catch			Length* (millimeters)		Catch			Length* (millimeters)	
	Number	Per cent	Rank	Range§	Mean	Number	Per cent	Rank	Range§	Mean
	July					August				
Butterfish	187	52.8	1	†	†	1,060	46.9	1	†	†
Bluefish	23	6.5	5	270–360	303.8	569	25.2	2	20–540	326.3
Blueback herring	..	..	..	..	..	7	0.3	11	110–140	120.0
Striped bass	49	13.8	2	325–775	504.3	366	16.2	3	325–700	450.6
Atlantic menhaden	1	0.3	11	†	†	41	1.8	5	†	†
Hickory shad	26	7.3	4	†	†	82	3.6	4	250–410	337.9
Striped mullet	..	..	..	..	..	..	..	..	..	..
Windowpane	..	..	..	..	..	1	tr.	17	255	..
Atlantic herring	..	..	..	..	..	..	..	..	..	..
Smooth dogfish	29	8.2	3	†	†	11	0.5	8	†	†
Roughtail stingray	7	2.0	6	†	†	36	1.6	6	†	†
Weakfish	1	0.3	11	365	..	6	0.3	12	310–450	358.3
Winter flounder	..	..	..	..	..	1	tr.	17	295	..
Atlantic moonfish	..	..	..	..	..	35	1.5	7	†	†
Longhorn sculpin	..	..	..	..	..	..	..	..	..	..
Northern kingfish	1	0.3	11	†	..	5	0.2	13	220–380	321.0
Alewife	6	1.7	7	†	†	..	..	..	..	..
Striped searobin	..	..	..	..	..	8	0.4	10	†	†
Clearnose skate	3	0.8	9	†	†	2	0.1	16	†	†
White mullet	..	..	..	..	..	..	..	..	..	..
Northern puffer	4	1.1	8	†	†	4	0.2	14	†	†
American shad....	6	1.7	7	†	†	1	tr.	17	445	..
Winter skate	..	..	..	..	..	..	..	..	..	..
Orange filefish	..	..	..	..	..	9	0.4	9	†	†
Tautog	..	..	..	..	..	2	0.1	16	190–200	195.0
Silver perch	2	0.6	10	†	†	2	0.1	16	170–190	180.0
Planehead filefish	4	1.1	8	†	†	1	tr.	17	†	..
Bigeye scad	..	..	..	..	..	4	0.2	14	†	†
Crevalle jack	..	..	..	..	..	..	..	..	..	..
Striped burrfish	1	0.3	11	†	..	1	tr.	17	†	..
Banded rudderfish	..	..	..	..	..	4	0.2	14	†	†
Summer flounder	..	..	..	..	..	3	0.1	15	350–490	415.0
Grubby	2	0.6	10	†	†	..	..	..	..	..
Goosefish	..	..	..	..	..	..	..	..	..	..
Leatherjacket	1	0.3	11	235		..	..	..	..	..
Sand shark	1	0.3	11	†		..	..	..	..	..
Pompano	..	..	..	..	..	1	tr.	17	†	..
Round scad	..	..	..	..	..	..	..	..	..	..
Lookdown				..	..	..	..	..	..	..
Spot				..	..	..	..	..	..	..
Total	354	100.0	xxx	xxx	xxx	2,262	100.0	xxx	xxx	xxx

Table 4. *(continued)*

Species	Catch			Length* (millimeters)		Catch			Length* (millimeters)	
	Number	Per cent	Rank	Range§	Mean	Number	Per cent	Rank	Range§	Mean
	September					October				
Butterfish	613	68.0	1	90–150	124.2	14	2.9	7	130–180	152.1
Bluefish	89	9.9	3	50–500	241.1	97	20.4	2	100–600	182.9
Blueback herring	1	0.1	11	245		68	14.3	3	120–160	141.9
Striped bass	122	13.5	2	350–1175	485.4	127	26.7	1	350–1100	513.0
Atlantic menhaden	13	1.4	6	140–180	164.2	9	1.9	9	110–130	119.4
Hickory shad	16	1.8	5	320–390	347.5	4	0.8	14	290–390	347.5
Striped mullet	..	..	..	..	..	65	13.7	4	180–260	206.8
Windowpane	..	..	..	..	..	1	0.2	16	335	
Atlantic herring	..	..	..	..	..	2	0.4	15	180–250	215.0
Smooth dogfish	1	0.1	11	†		2	0.4	15	475–525	500.0
Roughtail stingray	1	0.1	11	†		..	..	..	..	..
Weakfish	17	1.9	4	180–350	248.5	18	3.8	5	150–400	242.2
Winter flounder	4	0.4	8	250–310	287.5	4	0.8	14	240–350	292.5
Atlantic moonfish	2	0.2	10	†	†	..	..	..	..	..
Longhorn sculpin	..	..	..	..	..	..	..	..	..	..
Northern kingfish	5	0.6	7	220–250	235.0	8	1.7	10	110–370	268.7
Alewife	3	0.3	9	140–240	191.6	5	1.1	13	120–150	135.0
Striped searobin	3	0.3	9	†	†	7	1.5	11	310–380	346.4
Clearnose skate	..	..	..	..	..	10	2.1	8	400–940	537.2
White mullet	..	..	..	..	..	15	3.2	6	80–240	131.7
Northern puffer	4	0.4	8	130–230	185.0	2	0.4	15	200–270	235.0
American shad	..	..	..	..	..	..	..	..	..	..
Winter skate	..	..	..	..	..	1	0.2	16	415	
Orange filefish	1	0.1	11	†		..	..	..	..	..
Tautog	1	0.1	11	235		6	1.3	12	320–380	350.0
Silver perch	3	0.3	9	120–190	151.7	1	0.2	16	145	
Planehead filefish	..	..	..	..	..	..	..	..	..	..
Bigeye scad	1	0.1	11	†		..	..	..	..	..
Crevalle jack	..	..	..	..	..	5	1.1	13	90–110	99.0
Striped burrfish	..	..	..	..	..	2	0.4	15	80–120	100.0
Banded rudderfish	..	..	..	..	..	..	..	..	..	..
Summer flounder	1	0.1	11	395		..	..	..	..	..
Grubby	..	..	..	..	..	..	..	..	..	..
Goosefish	..	..	..	..	..	..	..	..	..	..
Leatherjacket	..	..	..	..	..	..	..	..	..	..
Sand shark	..	..	..	..	..	..	..	..	..	..
Pompano	..	..	..	..	..	..	..	..	..	..
Round scad	1	0.1	11	115		..	..	..	..	..
Lookdown	..	..	..	..	..	1	0.2	16	†	
Spot	..	..	..	..	..	1	0.2	16	175	
Total	902	100.0	xxx	xxx	xxx	475	100.0	xxx	xxx	xxx

TABLE 4. *(continued)*

Species	Catch			Length* (millimeters)		Catch			Length* (millimeters)	
	Number	Per cent	Rank	Range§	Mean	Number	Per cent	Rank	Range§	Mean
	November					Total				
Butterfish	..	..	..	..	..	1,874	35.9	1	90-180	138.7
Bluefish	47	4.3	5	120–350	143.7	825	16.3	2	20-600	260.1
Blueback herring	669	61.8	1	130–310	221.5	745	14.7	3	110–310	204.8
Striped bass	25	2.3	8	375–775	475.5	689	13.6	4	325–1175	473.0
Atlantic menhaden	120	11.1	2	70–130	96.5	184	3.6	5	70–180	110.8
Hickory shad	5	0.5	12	280-370	331.0	133	2.6	6	250–410	339.4
Striped mullet	3	0.3	13	210-240	221.7	68	1.3	7	180-260	207.5
Windowpane	60	5.5	3	240–380	310.0	62	1.2	8	240–380	309.5
Atlantic herring	57	5.3	4	210-300	255.7	59	1.2	9	180–300	254.3
Smooth dogfish	1	0.1	15	485		44	0.9	10	475–525	495.8
Roughtail stingray	..	..	..	..	..	44	0.9	10	†	†
Weakfish	2	0.2	14	160–190	175.0	44	0.9	10	150–450	259.4
Winter flounder	33	3.0	6	250–380	308.9	42	0.8	11	250-380	305.0
Atlantic moonfish	..	..	..	..	..	37	0.7	12	†	†
Longhorn sculpin	32	3.0	7	260-360	309.1	32	0.6	13	260-360	309.1
Northern kingfish	2	0.2	14	190–210	200.0	21	0.4	14	110-380	272.1
Alewife	6	0.6	11	240-290	266.6	20	0.4	15	120–290	203.5
Striped searobin	..	..	..	..	..	18	0.4	16	310-380	346.4
Clearnose skate	1	0.1	15	615		16	0.3	17	400-940	545.0
White mullet	..	..	..	..	..	15	0.3	18	80–240	131.7
Northern puffer	1	0.1	15	235		15	0.3	18	130-270	210.0
American shad	7	0.6	10	230–270	250.7	14	0.3	19	230-450	275.0
Winter skate	9	0.8	9	430–910	672.8	10	0.2	20	410-910	647.0
Orange filefish	..	..	..	..	..	10	0.2	20	†	†
Tautog	1	0.1	15	245		10	0.2	20	190-380	297.0
Silver perch	..	..	..	..	..	8	0.2	21	120–190	160.0
Planehead filefish	..	..	..	..	..	5	0.1	22	†	†
Bigeye scad	..	..	..	..	..	5	0.1	22	†	†
Crevalle jack	..	..	..	..	..	5	0.1	22	90–110	99.0
Striped burrfish	..	..	..	..	..	4	0.1	23	80–120	100.0
Banded rudderfish	..	..	..	..	..	4	0.1	23	†	†
Summer flounder	..	..	..	..	..	4	0.1	23	350 490	410.0
Grubby	..	..	..	..	..	2	tr.	24	†	†
Goosefish	2	0.2	14	420–600	510.0	2	tr.	24	420-600	510.0
Leatherjacket	..	..	..	..	..	1	tr.	25	235	
Sand shark	..	..	..	..	..	1	tr.	25	†	
Pompano	..	..	..	..	..	1	tr.	25	†	
Round scad	..	..	..	..	..	1	tr.	25	115	
Lookdown	..	..	..	..	..	1	tr.	25	†	
Spot	..	..	..	..	..	1	tr.	25	175	
Total	1,083	100.0	xxx	xxx	xxx	5,076	100.0	xxx	xxx	xxx

* In fork length for species having forked tail; in total length for others.
§ Single numerals represent the length of the one specimen recorded.
† Data not recorded.

TABLE 5. MONTHLY SPECIES AND SIZE COMPOSITION OF THE CATCH IN 1962

Species	Catch			Length* (millimeters)		Catch			Length* (millimeters)	
	Number	Per cent	Rank	Range§	Mean	Number	Per cent	Rank	Range§	Mean
	May					June				
Northern puffer	9,304	88.4	1	130–300	203.4	6,849	64.7	1	100–290	202.1
Blueback herring	3	tr.	18	170–190	181.6	1,367	12.9	2	110–290	242.0
Butterfish	..	..	..	..	..	302	2.9	6	70–210	149.2
Striped bass	273	2.6	3	250–975	528.1	118	1.1	7	375–1175	533.8
Hickory shad	110	1.0	5	140–390	269.1	364	3.4	5	200–400	317.2
Alewife	93	0.9	6	120–330	248.4	559	5.3	3	100–320	215.7
American shad	11	0.1	13	160–480	418.6	553	5.2	4	150–460	231.2
Windowpane	281	2.7	2	180–380	296.2	98	0.9	8	200–380	301.9
Striped searobin	9	0.1	14	300–390	352.7	11	0.1	15	280–440	355.0
Northern kingfish	186	1.8	4	220–410	311.5	63	0.6	11	220–390	273.2
Bluefish	4	tr.	17	360–470	417.5	96	0.9	9	220–640	302.2
Atlantic moonfish	..	..	..	..	..	..	..	..	..	..
Smooth dogfish	11	0.1	13	525–1125	928.4	43	0.4	12	500–1150	701.5
Atlantic menhaden	3	tr.	18	280–440	345.0	40	0.4	13	270–350	301.0
Weakfish	5	tr.	16	220–440	329.0	66	0.6	10	190–460	310.9
Little skate	69	0.7	7	310–590	438.3	6	0.1	17	350–570	456.7
White mullet	..	..	..	..	..	..	..	..	..	..
Planehead filefish	..	..	..	..	..	..	..	..	..	..
Winter skate	46	0.4	8	300–950	481.1	3	tr.	20	420–460	441.7
Summer flounder	20	0.2	11	270–640	413.5	12	0.1	14	300–470	384.2
Winter flounder	40	0.4	9	140–400	313.8	1	tr.	21	305	
Tautog	22	0.2	10	200–490	318.2	5	tr.	18	320–460	375.0
Clearnose skate	14	0.1	12	620–880	730.4	7	0.1	16	600–850	752.1
Crevalle jack	..	..	..	..	..	..	..	..	..	..
Roughtail stingray	..	..	..	..	..	4	tr.	19	830–1570	1200.0
Orange filefish	..	..	..	..	..	..	..	..	..	..
Silver perch	..	..	..	..	..	7	0.1	16	180–230	211.7
Striped mullet	..	..	..	..	..	..	..	..	..	..
Striped burrfish	..	..	..	..	..	11	0.1	15	190–260	222.3
Bay anchovy	..	..	..	..	..	..	..	..	..	..
Atlantic bonito	..	..	..	..	..	..	..	..	..	..
Squirrel hake	9	0.1	14	350–490	421.7	..	..	..	..	..
Goosefish	7	0.1	15	790–1080	965.0	1	tr.	21	815	
Lookdown	..	..	..	..	..	..	..	..	..	..
Atlantic mackerel	..	..	..	..	..	1	tr.	21	315	
Cornet fish	..	..	..	..	..	..	..	..	..	..
Northern pipefish	..	..	..	..	..	..	..	..	..	..
Dusky shark	..	..	..	..	..	..	..	..	..	..
Banded rudderfish	..	..	..	..	..	..	..	..	..	..
Sand shark	..	..	..	..	..	1	tr.	21	1115	
Round scad	..	..	..	..	..	..	..	..	..	..
Northern sennet	..	..	..	..	..	..	..	..	..	..
Spotted seahorse	..	..	..	..	..	..	..	..	..	..
Silver hake	1	tr.	19	365		..	..	..	..	..
Northern searobin	..	..	..	..	..	1	tr.	21	135	
Atlantic croaker	..	..	..	..	..	1	tr.	21	335	
Atlantic cutlassfish	..	..	..	..	..	..	..	..	..	..
Shortnose sturgeon	..	..	..	..	..	..	..	..	..	..
Sandbar shark	..	..	..	..	..	..	..	..	..	..
Blue runner	..	..	..	..	..	..	..	..	..	..
Mackerel scad	..	..	..	..	..	..	..	..	..	..
Oyster toadfish	..	..	..	..	..	..	..	..	..	..
Atlantic needlefish	..	..	..	..	..	..	..	..	..	..
Smooth puffer	..	..	..	..	..	..	..	..	..	..
Spot	..	..	..	..	..	..	..	..	..	..
Cunner	..	..	..	..	..	1	tr.	21	†	..
Total	10,521	100.0	xxx	xxx	xxx	10,591	100.0	xxx	xxx	xxx

TABLE 5. (*continued*)

Species	Catch			Length* (millimeters)		Catch			Length* (millimeters)	
	Number	Per cent	Rank	Range§	Mean	Number	Per cent	Rank	Range§	Mean
	July					August				
Northern puffer	46	3.8	6	170–270	219.7	14	1.5	8	70–260	177.1
Blueback herring	1	0.1	18	215		..	..	..	..	..
Butterfish	193	15.8	3	20–220	129.2	90	9.7	3	20–130	58.8
Striped bass	278	22.7	1	340–1075	505.2	373	40.1	1	350–900	499.2
Hickory shad	265	21.6	2	202–400	328.4	34	3.7	6	250–430	322.0
Alewife	6	0.5	14	130–260	201.6	..	..	..	..	..
American shad	..	..	..	..	..	1	0.1	17	465	..
Windowpane	21	1.7	9	150–350	281.1	9	1.0	11	60–350	263.8
Striped searobin	63	5.1	5	210–430	338.6	192	20.6	2	130–470	338.3
Northern kingfish	..	..	..	..	..	11	1.2	10	60–400	218.6
Bluefish	63	5.1	5	300–550	362.1	18	1.9	7	60–640	337.8
Atlantic moonfish	102	8.3	4	30–60	47.4	72	7.7	4	40–80	57.9
Smooth dogfish	44	3.6	7	475–1025	595.5	12	1.3	9	500–1150	733.3
Atlantic menhaden	46	3.8	6	270–360	315.7	..	..	..	..	..
Weakfish	1	0.1	18	365		3	0.3	15	†	195.0
Little skate	..	..	..	..	..	..	..	..	..	..
White mullet	..	..	..	..	..	..	..	..	..	..
Planehead filefish	..	..	..	..	..	48	5.2	5	30–110	67.3
Winter skate	..	..	..	..	..	..	..	..	..	..
Summer flounder	9	0.7	12	370–440	408.3	2	0.2	16	330–360	345.0
Winter flounder	..	..	..	..	..	..	..	..	..	..
Tautog	1	0.1	18	305	..	5	0.5	13	50–360	187.0
Clearnose skate	8	0.7	13	510–750	653.8	4	0.4	14	580–690	635.0
Crevalle jack	22	1.8	8	20–50	35.0	..	..	..	..	..
Roughtail stingray	13	1.1	10	740–1380	1493.5	6	0.6	12	†	1525.0
Orange filefish	10	0.8	11	90–140	116.0	12	1.3	9	90–180	130.0
Silver perch	8	0.7	13	150–220	197.5	1	0.1	17	195	
Striped mullet	..	..	..	..	..	..	..	..	..	..
Striped burrfish	..	..	..	..	..	1	0.1	17	185	
Bay anchovy	10	0.8	11	70–90	79.4	..	..	..	..	..
Atlantic bonito	..	..	..	..	..	..	..	..	..	..
Squirrel hake	..	..	..	..	..	..	..	..	..	..
Goosefish	..	..	..	..	..	..	..	..	..	..
Lookdown	..	..	..	..	..	6	0.6	12	30–60	43.3
Atlantic mackerel	5	0.4	15	70–100	87.0	..	..	..	..	..
Cornet fish	..	..	..	..	..	2	0.2	16	†	165.0
Northern pipefish	..	..	..	..	..	4	0.4	14	130–180	147.5
Dusky shark	3	0.2	17	1030–1230	1198.3	1	0.1	17	1135	
Banded rudderfish	4	0.3	16	80–160	107.5	..	..	..	..	..
Sand shark	..	..	..	..	..	1	0.1	17	1265	
Round scad	1	0.1	18	45		..	..	..	..	..
Northern sennet	..	..	..	..	..	2	0.2	16	70–100	85.0
Spotted seahorse	..	..	..	..	..	2	0.2	16	†	†
Silver hake	..	..	..	..	..	..	..	..	..	..
Northern searobin	..	..	..	..	..	..	..	..	..	..
Atlantic croaker	..	..	..	..	..	..	..	..	..	..
Atlantic cutlassfish	1	0.1	18	715		..	..	..	..	..
Shortnose sturgeon	1	0.1	18	705		..	..	..	..	..
Sandbar shark	..	..	..	..	..	1	0.1	17	1185	
Blue runner	..	..	..	..	..	1	0.1	17	155	
Mackerel scad	..	..	..	..	..	1	0.1	17	55	
Oyster toadfish	..	..	..	..	..	1	0.1	17	225	..
Atlantic needlefish	..	..	..	..	..	..	..	..	..	..
Smooth puffer										
Spot										
Cunner										
Total	1,225	100.0	xxx	xxx	xxx	930	100.0	xxx	xxx	xxx

TABLE 5. *(continued)*

Species	Catch			Length* (millimeters)		Catch			Length* (millimeters)	
	Number	Per cent	Rank	Range§	Mean	Number	Per cent	Rank	Range§	Mean
	September					October				
Northern puffer	53	7.2	4	90–260	171.9	1	0.2	13	135	
Blueback herring	..	..	..	..	..	..	..	..	..	..
Butterfish	431	59.2	1	50–110	73.2	260	59.5	1	60–200	89.1
Striped bass	57	7.8	3	350–700	517.7	50	11.4	2	375–1175	590.0
Hickory shad	25	3.4	6	250–390	331.4	11	2.5	6	310–380	344.0
Alewife	..	..	..	..	..	..	..	..	..	..
American shad	..	..	..	..	..	..	..	..	..	..
Windowpane	6	0.8	9	240–340	278.3	4	0.9	10	290–340	310.0
Striped searobin	32	4.4	5	300–410	348.1	..	..	..	..	..
Northern kingfish	2	0.3	12	240–310	275.0	14	3.2	4	240–410	340.0
Bluefish	21	2.9	7	160–580	406.9	44	10.1	3	110–530	236.6
Atlantic moonfish	..	..	..	..	..	..	..	..	..	..
Smooth dogfish	1	0.1	13	615		3	0.7	11	500–600	545.8
Atlantic menhaden	..	..	..	..	..	7	1.6	8	100–210	173.6
Weakfish	..	..	..	..	..	10	2.3	7	350–460	401.0
Little skate.	1	0.1	13	†		2	0.5	12	420–480	450.0
White mullet	64	8.7	2	110–160	139.1	1	0.2	13	145	
Planehead filefish	2	0.3	12	80–90	85.0	1	0.2	13	105	
Winter skate	..	..	..	..	..	1	0.2	13	445	
Summer flounder	1	0.1	13	415		..	..	..	..	..
Winter flounder	1	0.1	13	275		1	0.2	13	335	
Tautog	5	0.7	10	170–240	290.0	..	..	..	..	..
Clearnose skate	..	..	..	..	..	..	..	..	..	..
Crevalle jack	5	0.7	10	110–140	125.0	6	1.4	9	110–200	168.3
Roughtail stingray	3	0.4	11	1520–2000	1741.6	..	..	..	..	..
Orange filefish	2	0.3	12	110–140	125.0	1	0.2	13	225	
Silver perch	..	..	..	..	..	4	0.9	10	140–220	162.5
Striped mullet	2	0.3	12	220–250	235.0	13	3.0	5	190–240	211.9
Striped burrfish	..	..	..	..	..	1	0.2	13	95	
Bay anchovy	..	..	..	..	..	..	..	..	..	..
Atlantic bonito	10	1.4	8	210–270	234.0	..	..	..	..	..
Squirrel hake	..	..	..	..	..	..	..	..	..	..
Goosefish	..	..	..	..	..	..	..	..	..	..
Lookdown	1	0.1	13	55		..	..	..	..	..
Atlantic mackerel	..	..	..	..	..	..	..	..	..	..
Cornet fish	1	0.1	13	235		2	0.5	12	†	175.0
Northern pipefish	..	..	..	..	..	..	..	..	..	..
Dusky shark	..	..	..	..	..	..	..	..	..	..
Banded rudderfish	..	..	..	..	..	..	..	..	..	..
Sand shark	..	..	..	..	..	..	..	..	..	..
Round scad	1	0.1	13	65		..	..	..	..	..
Northern sennet	..	..	..	..	..	..	..	..	..	..
Spotted seahorse	..	..	..	..	..	..	..	..	..	..
Silver hake	..	..	..	..	..	..	..	..	..	..
Northern searobin	..	..	..	..	..	..	..	..	..	..
Atlantic croaker	..	..	..	..	..	..	..	..	..	..
Atlantic cutlassfish	..	..	..	..	..	..	..	..	..	..
Shortnose sturgeon	..	..	..	..	..	..	..	..	..	..
Sandbar shark	..	..	..	..	..	..	..	..	..	..
Blue runner	..	..	..	..	..	..	..	..	..	..
Mackerel scad	..	..	..	..	..	..	..	..	..	..
Oyster toadfish	..	..	..	..	..	..	..	..	..	..
Atlantic needlefish	1	0.1	13	265		..	..	..	..	..
Smooth puffer	1	0.1	13	95		..	..	..	..	..
Spot	1	0.1	13	195		..	..	..	..	..
Cunner	..	..	..	..	..	..	..	..	..	..
Total	733	100.0	xxx	xxx	xxx	437	100.0	xxx	xxx	xxx

TABLE 5. (*continued*)

Species	Catch			Length * (millimeters)	
	Number	Per cent	Rank	Range§	Mean
	Total				
Northern puffer	16,267	66.6	1	70–300	201.2
Blueback herring	1,371	5.6	2	110–290	241.2
Butterfish	1,279	5.2	3	20–220	99.3
Striped bass	1,149	4.7	4	250–1175	517.4
Hickory shad	809	3.3	5	140–430	311.5
Alewife	658	2.7	6	100–330	226.0
American shad	565	2.3	7	150–480	247.6
Windowpane	419	1.7	8	60–380	295.9
Striped searobin	307	1.3	9	130–470	340.4
Northern kingfish	276	1.1	10	60–410	300.3
Bluefish	246	1.0	11	60–650	318.5
Atlantic moonfish	174	0.7	12	30–80	51.8
Smooth dogfish	114	0.5	13	475–1150	680.9
Atlantic menhaden	96	0.4	14	100–440	300.2
Weakfish	85	0.3	15	190–460	322.1
Little skate	78	0.3	16	310–590	440.1
White mullet	65	0.3	17	110–160	139.2
Planehead filefish	51	0.2	18	30–110	68.7
Winter skate	50	0.2	19	300–950	478.0
Summer flounder	44	0.2	20	270–640	401.4
Winter flounder	43	0.2	21	140–400	313.1
Tautog	38	0.2	22	50–490	293.2
Clearnose skate	33	0.1	23	510–880	731.7
Crevalle jack	33	0.1	23	20–200	74.1
Roughtail stingray	26	0.1	24	740–2000	1474.5
Orange filefish	25	0.1	25	90–230	127.8
Silver perch	20	0.1	26	140–230	194.5
Striped mullet	15	0.1	27	190–250	215.0
Striped burrfish	13	0.1	28	90–260	209.6
Bay anchovy	10	tr.	29	70–90	79.4
Atlantic bonito	10	tr.	29	210–270	234.0
Squirrel hake	9	tr.	30	350–490	421.7
Goosefish	8	tr.	31	790–1080	943.6
Lookdown	7	tr.	32	30–60	45.0
Atlantic mackerel	6	tr.	33	70–320	124.2
Cornet fish	5	tr.	34	160–240	191.7
Northern pipefish	4	tr.	35	130–180	147.5
Dusky shark	4	tr.	35	1030 1230	1137.5
Banded rudderfish	4	tr.	35	80–160	107.5
Sand shark	2	tr.	36	1110–1270	1190 0
Round scad	2	tr.	36	40–70	55.0
Northern sennet	2	tr.	36	70 100	85 0
Spotted seahorse	2	tr.	36	†	†
Silver hake	1	tr.	37	365	
Northern searobin	1	tr.	37	135	
Atlantic croaker	1	tr.	37	335	
Atlantic cutlassfish	1	tr.	37	715	
Shortnose sturgeon	1	tr.	37	705	
Sandbar shark	1	tr.	37	1185	
Blue runner	1	tr.	37	155	
Mackerel scad	1	tr.	37	55	
Oyster toadfish	1	tr.	37	225	
Atlantic needlefish	1	tr.	37	265	
Smooth puffer	1	tr.	37	95	
Spot	1	tr.	37	195	
Cunner	1	tr.	37	†	
Total	24,437	100.0	xxx	xxx	xxx

* In fork length for species having forked tail; in total length for others.
§ Single numerals represent the length of the one specimen recorded.
† Data not recorded.

Table 6. Monthly Species and Size Composition of the Catch in 1963

Species	Catch			Length* (millimeters)		Catch			Length* (millimeters)	
	Number	Per cent	Rank	Range§	Mean	Number	Per cent	Rank	Range§	Mean
	May					June				
Northern puffer	21,084	91.3	1	100-310	207.9	2,807	26.1	2	100-330	211.7
Alewife	744	3.2	2	110-310	216.9	2,857	26.5	1	110-300	189.8
Hickory shad	198	0.9	5	170-410	298.9	1,482	13.8	4	180-420	310.0
Striped bass	378	1.6	3	200-1100	481.2	266	2.5	8	375-1150	624.1
Blueback herring	37	0.2	11	90-300	204.1	1,748	16.2	3	80-310	216.0
Butterfish	1	tr.	18	115		388	3.6	5	60-230	171.5
American shad	173	0.7	6	140-560	198.3	357	3.3	7	150-520	238.6
Smooth dogfish	3	tr.	16	550-1225	954.2	379	3.5	6	425-1225	651.7
Striped searobin	5	tr.	15	250-410	333.0	46	0.4	10	110-460	344.6
Atlantic menhaden	243	1.1	4	280-370	325.7	11	0.1	17	220-340	292.3
Windowpane	38	0.2	10	80-350	284.4	184	1.7	9	70-370	278.8
Bluefish	1	tr.	18	525		11	0.1	17	260-430	328.6
Silver perch	51	0.2	8	160-240	189.3	19	0.2	13	140-210	174.5
Northern kingfish	53	0.2	7	230-370	300.6	36	0.3	11	230-380	299.7
Weakfish	8	tr.	13	110-420	290.0	46	0.4	10	200-590	289.8
Tautog	39	0.2	9	190-520	336.8	11	0.1	17	220-410	287.7
Clearnose skate	3	tr.	16	750-850	801.7	18	0.2	14	530-730	620.6
Roughtail stingray	..	..	..	..	..	17	0.2	15	990-2880	1738.5
Little skate	3	tr.	16	430-680	515.0	25	0.2	12	300-580	444.2
Winter flounder	18	0.1	12	220-350	276.1	2	tr.	21	260-280	270.0
Summer flounder	1	tr.	18	575		19	0.2	13	330-520	403.9
Striped burrfish	..	..	..	..	..	16	0.1	16	160-220	186.3
Northern searobin	1	tr.	18	265		8	0.1	18	230-460	296.3
Bay anchovy	..	..	..	..	..	7	0.1	19	60- 80	69.3
Atlantic moonfish	..	..	..	..	..	..	..	..	..	..
Longhorn sculpin	..	..	..	..	..	..	..	..	..	..
Atlantic herring	6	tr.	14	200-310	263.3	..	..	..	..	..
Lookdown	..	..	..	..	..	..	..	..	..	..
Winter skate	1	tr.	18	425		2	tr.	21	530-550	440.0
Goosefish	1	tr.	18	925		..	..	..	..	..
Atlantic bonito	..	..	..	..	..	..	..	..	..	..
Orange filefish	..	..	..	..	..	..	..	..	..	..
Bigeye scad	..	..	..	..	..	..	..	..	..	..
African pompano	..	..	..	..	..	..	..	..	..	..
Sand shark	..	..	..	..	..	3	tr.	20	1060-1310	1181.7
White perch	2	tr.	17	180-250	215.0	..	..	..	..	..
Scup	1	tr.	18	115		1	tr.	22	105	
Atlantic mackerel	..	..	..	..	..	..	..	..	..	..
Atlantic round herring	..	..	..	..	..	..	..	..	..	..
Planehead filefish	..	..	..	..	..	..	..	..	..	..
Atlantic silverside	..	..	..	..	..	..	..	..	..	..
Blue runner	..	..	..	..	..	..	..	..	..	..
Striped mullet	..	..	..	..	..	..	..	..	..	..
Squirrel hake	1	tr.	18	515		..	..	..	..	..
Atlantic sturgeon	..	..	..	..	..	1	tr.	22	705	
Rough scad	..	..	..	..	..	1	tr.	22	65	
Sandbar shark	..	..	..	..	..	..	..	..	..	..
Crevalle jack	..	..	..	..	..	..	..	..	..	..
Cownose ray	..	..	..	..	..	..	..	..	..	..
Spiny dogfish	..	..	..	..	..	..	..	..	..	..
Total	23,094	100.0	xxx	xxx	xxx	10,768	100.0	xxx	xxx	xxx

TABLE 6. (*continued*)

Species	Catch			Length* (millimeters)		Catch			Length* (millimeters)	
	Number	Per cent	Rank	Range§	Mean	Number	Per cent	Rank	Range§	Mean
	July					August				
Northern puffer	416	35.6	1	150–290	217.9	404	28.1	1	50–270	125.0
Alewife	11	0.9	9	120–300	200.4	5	0.3	13	150–260	213.0
Hickory shad	401	34.3	2	210–400	315.9	192	13.3	4	230–410	332.7
Striped bass	83	7.1	3	325–1110	551.6	125	8.7	5	275–850	485.5
Blueback herring	28	2.4	7	110–260	183.5	..	..	..	..	..
Butterfish	38	3.2	6	30–210	92.8	332	23.1	2	20–210	86.2
American shad	1	0.1	16	425		1	0.1	17	245	
Smooth dogfish	68	5.8	4	450–775	575.0	32	2.2	7	500–775	600.8
Striped searobin	23	2.0	8	240–380	325.0	213	14.8	3	210–410	319.9
Atlantic menhaden	..	..	..	..	..	11	0.8	9	280–360	319.5
Windowpane	9	0.8	10	120–320	236.1	10	0.7	10	80–330	181.0
Bluefish	6	0.5	12	310–610	451.7	47	3.3	6	30–670	222.9
Silver perch	45	3.8	5	130–210	183.7	..	..	..	..	..
Northern kingfish	..	..	..	..	..	..	..	..	..	..
Weakfish	3	0.3	14	230–410	311.7	..	..	..	..	..
Tautog	3	0.3	14	180–400	271.7	1	0.1	17	215	
Clearnose skate	8	0.7	11	570–790	637.5	20	1.4	8	470–680	593.0
Roughtail stingray	11	0.9	9	1020–2410	1864.0	8	0.6	11	1320–3090	1872.5
Little skate	1	0.1	16	475		2	0.1	16	410–460	435.0
Winter flounder	..	..	..	..	..	..	..	..	..	..
Summer flounder	2	0.2	15	390–440	415.0	2	0.1	16	340–430	385.0
Striped burrfish	1	0.1	16	185		1	0.1	17	195	
Northern searobin	..	..	..	..	..	2	0.1	16	140–280	210.0
Bay anchovy	4	0.3	13	60–80	72.5	..	..	..	..	..
Atlantic moonfish	1	0.1	16	35		7	0.5	12	50–60	55.0
Longhorn sculpin	..	..	..	..	..	..	..	..	..	..
Atlantic herring	..	..	..	..	..	..	..	..	..	..
Lookdown	1	0.1	16	35		4	0.3	14	30–60	42.5
Winter skate	..	..	..	..	..	..	..	..	..	..
Goosefish	..	..	..	..	..	..	..	..	..	..
Atlantic bonito	..	..	..	..	..	5	0.3	13	140–160	147.0
Orange filefish	1	0.1	16	115		2	0.1	16	150–190	170.0
Bigeye scad	..	..	..	..	..	3	0.2	15	120–140	131.7
African pompano	..	..	..	..	..	3	0.2	15	60–110	83.7
Sand shark	..	..	..	..	..	..	..	..	..	..
White perch	..	..	..	..	..	..	..	..	..	..
Scup	..	..	..	..	..	..	..	..	..	..
Atlantic mackerel	2	0.2	15	70–90	80.0	..	..	..	..	..
Atlantic round herring	2	0.2	15	100–110	105.0	..	..	..	..	..
Planehead filefish	..	..	..	..	..	2	0.1	16	40–70	55.0
Atlantic silverside	..	..	..	..	..	2	0.1	16	50–60	55.0
Blue runner	..	..	..	..	..	2	0.1	16	150–170	160.0
Striped mullet	..	..	..	..	..	..	..	..	..	..
Squirrel hake	..	..	..	..	..	..	..	..	..	
Atlantic sturgeon	..	..	..	..	..	..	..	..	..	
Rough scad	..	..	..	..	..	..	..	..	..	
Sandbar shark	1	0.1	16	1185		..	..	..	..	
Crevalle jack	..	..	..	..	..	1	0.1	17	45	
Cownose ray	..	..	..	..	..	..	..	..	..	..
Spiny dogfish	..	..	..	..	..	..	..	..	..	..
Total	1,170	100.0	xxx	xxx	xxx	1,439	100.0	xxx	xxx	xxx

TABLE 6. *(continued)*

Species	Catch			Length* (millimeters)		Catch			Length* (millimeters)	
	Number	Per cent	Rank	Range§	Mean	Number	Per cent	Rank	Range§	Mean
	September					October				
Northern puffer	4	1.1	4	110–230	190.0	13	1.1	4	190–270	232.6
Alewife	..	..	..	..	..	..	..	..	..	..
Hickory shad	81	22.6	2	250–430	334.3	7	0.6	5	330–400	359.2
Striped bass	18	5.0	3	375–650	523.6	1,048	90.4	1	225–1125	454.3
Blueback herring	..	..	..	..	..	..	..	..	..	..
Butterfish	251	69.9	1	50–110	79.8	6	0.5	6	90–120	103.3
American shad	..	..	..	..	..	..	..	..	..	..
Smooth dogfish	..	..	..	..	..	3	0.3	7	450–500	470.8
Striped searobin	..	..	..	..	..	..	..	..	..	..
Atlantic menhaden	..	..	..	..	..	..	..	..	..	..
Windowpane	..	..	..	..	..	1	0.1	9	315	..
Bluefish	1	0.3	5	405		51	4.4	2	70–690	476.1
Silver perch	..	..	..	..	..	..	..	..	..	..
Northern kingfish	..	..	..	..	..	2	0.2	8	310–340	325.0
Weakfish	..	..	..	..		17	1.5	3	210–660	444.4
Tautog	1	0.3	5	405		3	0.3	7	210–250	228.3
Clearnose skate	..	..	..	..	..	..	..	..	..	..
Roughtail stingray	1	0.3	5	1475		..	..	..	..	..
Little skate	1	0.3	5	545		..	..	..	..	..
Winter flounder	..	..	..	..	..	2	0.2	8	300–330	315.0
Summer flounder	..	..	..	..	..	..	..	..	..	..
Striped burrfish	..	..	..	..	..	1	0.1	9	85	..
Northern searobin	..	..	..	..	..	..	..	..	..	..
Bay anchovy	..	..	..	..	..	..	..	..	..	..
Atlantic moonfish	1	0.3	5	45		1	0.1	9	85	..
Longhorn sculpin	..	..	..	..	..	..	..	..	..	..
Atlantic herring	..	..	..	..	..	..	..	..	..	..
Lookdown	..	..	..	..	..	..	..	..	..	..
Winter skate	..	..	..	..	..	1	0.1	9	895	..
Goosefish	..	..	..	..	..	2	0.2	8	920–990	955.0
Atlantic bonito	..	..	..	..	..	..	..	..	..	..
Orange filefish	..	..	..	..	..	..	..	..	..	..
Bigeye scad	..	..	..	..	..	..	..	..	..	..
African pompano	..	..	..	..	..	..	..	..	..	..
Sand shark	..	..	..	..	..	..	..	..	..	..
White perch	..	..	..	..	..	..	..	..	..	..
Scup	..	..	..	..	..	..	..	..	..	..
Atlantic mackerel	..	..	..	..	..	..	..	..	..	..
Atlantic round herring	..	..	..	..	..	..	..	..	..	..
Planehead filefish	..	..	..	..	..	..	..	..	..	..
Atlantic silverside	..	..	..	..	..	..	..	..	..	..
Blue runner	..	..	..	..	..	..	..	..	..	..
Striped mullet	..	..	..	..	..	..	..	..	..	..
Squirrel hake	..	..	..	..	..	..	..	..	..	..
Atlantic sturgeon	..	..	..	..	..	..	..	..	..	..
Rough scad	..	..	..	..	..	..	..	..	..	..
Sandbar shark	..	..	..	..	..	..	..	..	..	..
Crevalle jack	..	..	..	..	..	..	..	..	..	..
Cownose ray	..	..	..	..	..	1	0.1	9	875	..
Spiny dogfish	..	..	..	..	..	..	..	..	..	..
Total	359	100.0	xxx	xxx	xxx	1,159	100.0	xxx	xxx	xxx

TABLE 6. *(continued)*

Species	Catch			Length* (millimeters)		Catch			Length* (millimeters)	
	Number	Per cent	Rank	Range§	Mean	Number	Per cent	Rank	Range§	Mean
	November					Total				
Northern puffer	..	..	..	..	..	24,728	64.4	1	50–330	203.2
Alewife	22	5.3	2	240–300	272.2	3,639	9.5	2	110–310	201.0
Hickory shad	2	0.5	7	330–350	340.0	2,363	6.2	3	170–430	313.3
Striped bass	342	82.2	1	325–850	502.4	2,260	5.9	4	200–1150	493.6
Blueback herring	14	3.4	3	240–300	272.8	1,827	4.8	5	80–310	215.1
Butterfish	..	..	..	..	..	1,016	2.6	6	20–230	124.2
American shad	2	0.5	7	220–240	230.0	534	1.4	7	140–560	225.5
Smooth dogfish	..	..	..	..	..	485	1.3	8	425–1225	638.3
Striped searobin	..	..	..	..	..	287	0.7	9	110–460	324.5
Atlantic menhaden	2	0.5	7	100–120	110.0	267	0.7	10	100–370	318.7
Windowpane	13	3.1	4	250–350	311.9	255	0.7	11	70–370	276.1
Bluefish	..	..	..	..	..	117	0.3	12	30–690	350.9
Silver perch	..	..	..	..	..	115	0.3	13	130–240	184.7
Northern kingfish	..	..	..	..	..	91	0.2	14	230–380	300.8
Weakfish	..	..	..	..	..	74	0.2	15	110–660	325.1
Tautog	..	..	..	..	..	58	0.2	16	180–520	317.6
Clearnose skate	..	..	..	..	..	49	0.1	17	470–850	623.2
Roughtail stingray	..	..	..	..	..	37	0.1	18	990–3090	1085.6
Little skate	..	..	..	..	..	32	0.1	19	300–680	454.4
Winter flounder	5	1.2	6	290–380	321.0	27	0.1	20	220–380	286.9
Summer flounder	..	..	..	..	..	24	0.1	21	330–580	410.4
Striped burrfish	..	..	..	..	..	19	tr.	22	80–220	181.3
Northern searobin	..	..	..	..	..	11	tr.	23	110–460	277.7
Bay anchovy	..	..	..	..	..	11	tr.	23	60–80	70.5
Atlantic moonfish	..	..	..	..	..	10	tr.	24	30–90	55.0
Longhorn sculpin	5	1.9	5	260–330	305.0	8	tr.	25	260–330	305.0
Atlantic herring	..	..	..	..	..	6	tr.	26	200–310	263.3
Lookdown	..	..	..	..	..	5	tr.	27	30–60	45.0
Winter skate	1	0.2	8	895		5	tr.	27	420–900	659.0
Goosefish	2	0.5	7	530–660	645.0	5	tr.	27	530–990	805.0
Atlantic bonito	..	..	..	..	..	5	tr.	27	140–160	147.0
Orange filefish	..	..	..	..	..	3	tr.	28	110–190	151.7
Bigeye scad	..	..	..	..	..	3	tr.	28	120–140	131.7
African pompano	..	..	..	..	..	3	tr.	28	60–110	83.7
Sand shark	..	..	..	..	..	3	tr.	28	1060–1310	1181.7
White perch	..	..	..	..	..	2	tr.	29	180–250	215.0
Scup	..	..	..	..	..	2	tr.	29	100–120	110.0
Atlantic mackerel	..	..	..	..	..	2	tr.	29	70–90	80.0
Atlantic round herring	..	..	..	..	..	2	tr.	29	100–110	105.0
Planehead filefish	..	..	..	..	..	2	tr.	29	40–70	55.0
Atlantic silverside	..	..	..	..	..	2	tr.	29	50–60	55.0
Blue runner	..	..	..	..	..	2	tr.	29	170–170	160.0
Striped mullet	2	0.5	7	210–220	215.0	2	tr.	29	210–220	215.0
Squirrel hake	..	..	..	..	..	1	tr.	30	515	
Atlantic sturgeon	..	..	..	..	..	1	tr.	30	705	
Rough scad	..	..	..	..	..	1	tr.	30	65	
Sandbar shark	..	..	..	..	..	1	tr.	30	1185	
Crevalle jack	..	..	..	..	..	1	tr.	30	45	
Cownose ray	..	..	..	..	..	1	tr.	30	875	
Spiny dogfish	1	0.2	8	735		1	tr.	30	735	
Total	416	100.0	xxx	xxx	xxx	38,405	100.0	xxx	xxx	xxx

* In fork length for species having forked tail; in total length for others.
§ Single numerals represent the length of the one specimen recorded.

Northern Puffer *(Sphaeroides maculatus)*

The northern puffer was the most abundant species taken during 1962 and 1963, contributing 16,267 (66.6 per cent) and 24,728 (64.4 per cent) individuals, respectively, to the catch. The greatest numbers were collected during May and June. Only a few were caught in 1961, but no seining was done during May and June; perhaps the species would have been better represented had sampling been done during those months.

Monthly length-frequency distributions for 1962 and 1963 are presented in Figure 5. The pattern from May through July was essentially unimodal, and the puffers measured ranged from less than 100 to more than 300 millimeters in length, with an average of slightly more than 200 millimeters. During August and September, however, the pattern became bimodal as a result of the addition of a group of smaller individuals, presumably young of the year, that averaged 100 millimeters in length. The age and growth of the northern puffer have never been precisely determined, but length-frequency data similar to those presented here[2] suggest that the population was composed of no more than three or four age groups.

Blueback Herring *(Alosa aestivalis)*

The blueback herring ranked third in the catch in 1961, second in 1962 and fifth in 1963. Collections were greatest in November of 1961 when it ranked first (61.8 per cent), in June of 1962 when it ranked second (12.9 per cent) and in June of 1963 when it ranked third (16.2 per cent). Perhaps, as in the case of the northern puffer, the catch in 1961 would have been much larger had sampling been done in June.

Lengths ranged from 80 to more than 300 millimeters, with a large proportion of the specimens taken in June of 1962 and 1963 approximating 250 millimeters (Figure 6). Although little is known of the growth of blueback herring beyond the first summer of life (Hildebrand and Schroeder, 1928; Bigelow and Schroeder, 1953), Hildebrand (1963) has suggested that the species reaches a length of 65 to 120 millimeters at age I, 140 to 184 millimeters at age II, about 200 millimeters at age III and about 250 millimeters at age IV. Based on these observations, apparently most of those taken in this study were 3 or more years old.

Butterfish *(Poronotus triacanthus)*

The butterfish ranked first in abundance in 1961, third in 1962 and sixth in 1963. In 1961 it comprised 36.9 per cent of the total

[2] James R. Westman, personal communication.

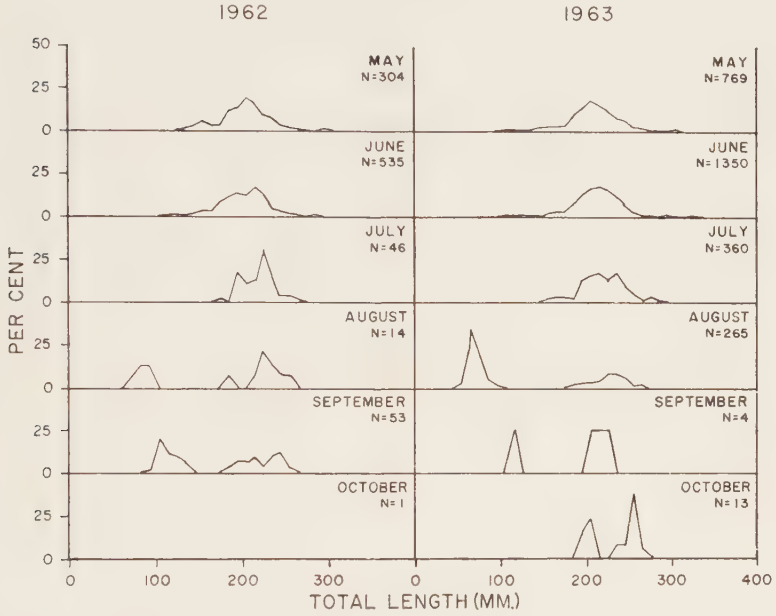


Figure 5. Monthly length-frequency distribution for northern puffer taken in 1962 and 1963.

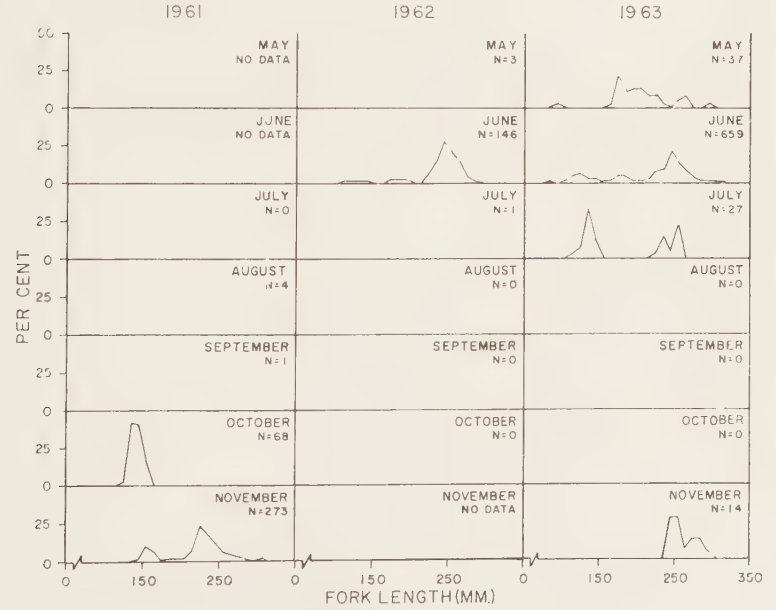


Figure 6. Monthly length-frequency distribution for blueback herring taken in 1961, 1962 and 1963.

catch. Butterfish were first collected in numbers during June of 1962 and 1963 and remained plentiful in the catches throughout the summer and into September when the species ranked between first and sixth. In 1962, the species was taken in large quantities as late as October when it was the most abundant fish in the collections.

Sizes ranged from 20 to 230 millimeters. Length-frequency distributions of fish collected in 1962 and 1963 exhibited two modes in June, one at approximately 150 millimeters and the other at approximately 200 millimeters (Figure 7). Following the growth observations presented by Hildebrand and Schroeder (1928) and Bigelow and Schroeder (1953), these fish were probably 1 and 2 years of age, respectively. Apparently most of the specimens collected from August through October, which were nearly all less than 100 millimeters in length, were young of the year.

Alewife *(Alosa pseudoharengus)*

The alewife ranked sixth in abundance in 1962 and second in 1963. Approximately 99 per cent of all alewives collected during these years were taken in May and June. However, no sampling was done in May and June of 1961, which probably accounts for the fact that only 20 specimens were captured in that year.

Alewives ranged from 100 to more than 300 millimeters in length. Hildebrand (1963), relying heavily on the earlier works of Bigelow and Welsh (1925) and Hildebrand and Schroeder (1928), suggested that the species attains a size of about 65 to 145 millimeters at 1 year of age and about 115 to 195 millimeters at 2 years. Moreover, Hildebrand and Schroeder (1928) suggested an average maximum length of 11 inches when 4 years old. In view of these observations, the modal groups of alewives taken in 1962 and 1963 (Figure 8) were probably composed of fish from 1 to 4 or more years of age.

Hickory Shad *(Alosa mediocris)*

Hickory shad ranged sixth, fifth and third, respectively, in the collections made in 1961, 1962 and 1963. Although more than 50 and 70 per cent, respectively, of those taken in 1962 and 1963 were captured during May and June, this species of herring, unlike *A. aestivalis* and *A. pseudoharengus*, was also collected in fairly large numbers throughout the summer and into the fall. Indeed, the hickory shad never ranked lower than sixth in abundance in any month from May through September.

Hickory shad were generally larger than either *A. aestivalis* or *A. pseudoharengus*, ranging from 140 to more than 400 millimeters in length. Most of the specimens, however, fell between 300 and 400 millimeters (Figure 9). This distribution was similar to that of the

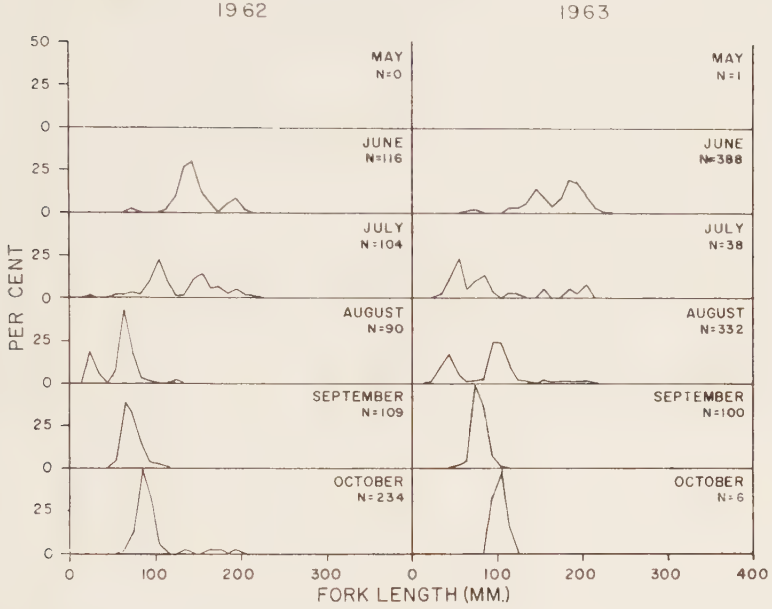


Figure 7. Monthly length-frequency distribution for butterfish taken in 1962 and 1963.

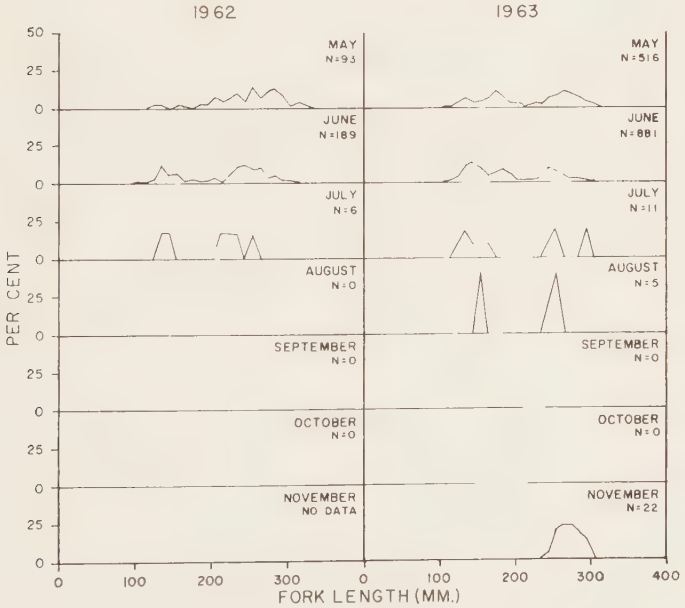


Figure 8. Monthly length-frequency distribution for alewives taken in 1962 and 1963.

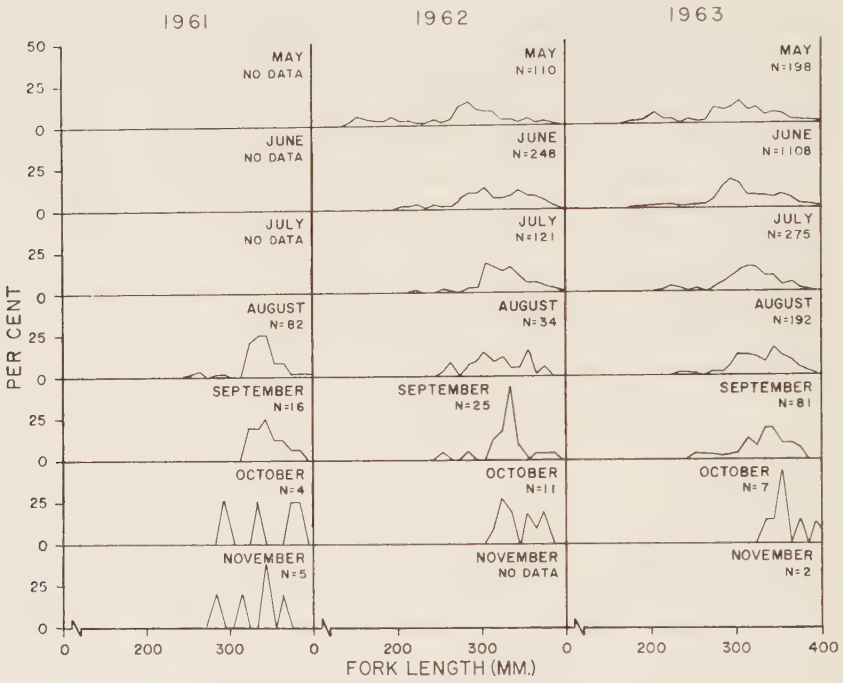


Figure 9. Monthly length-frequency distribution for hickory shad taken in 1961, 1962 and 1963. (Specimens over 400 millimeters long omitted for ease of presentation)

commercial catches of the species from Chesapeake Bay and at Beaufort, North Carolina (Hildebrand, 1963). Although almost nothing is known of its growth, limited data presented by Mansueti (1962) suggest that hickory shad attain lengths of about 150 to 200 millimeters when 1 year old. Presumably the present collections were composed of fish at least 1 year old.

Striped Bass *(Roccus saxatilis)*

This important commercial and sport fish ranked fourth in abundance each year, comprising 13.6 per cent of the catch in 1961, 4.7 per cent in 1962 and 5.9 per cent in 1963. Monthly data indicate, also, that it was among the most frequently collected species. Specimens were taken in fairly large numbers in every month of the study period except for November in 1962 when sampling was precluded because of bad weather.

Although striped bass ranged in length from as small as 200 millimeters in May of 1963 to as large as 1,175 millimeters in September of 1961 and in June and October of 1962, monthly length-frequency distributions (Figure 10) indicate that most specimens were between

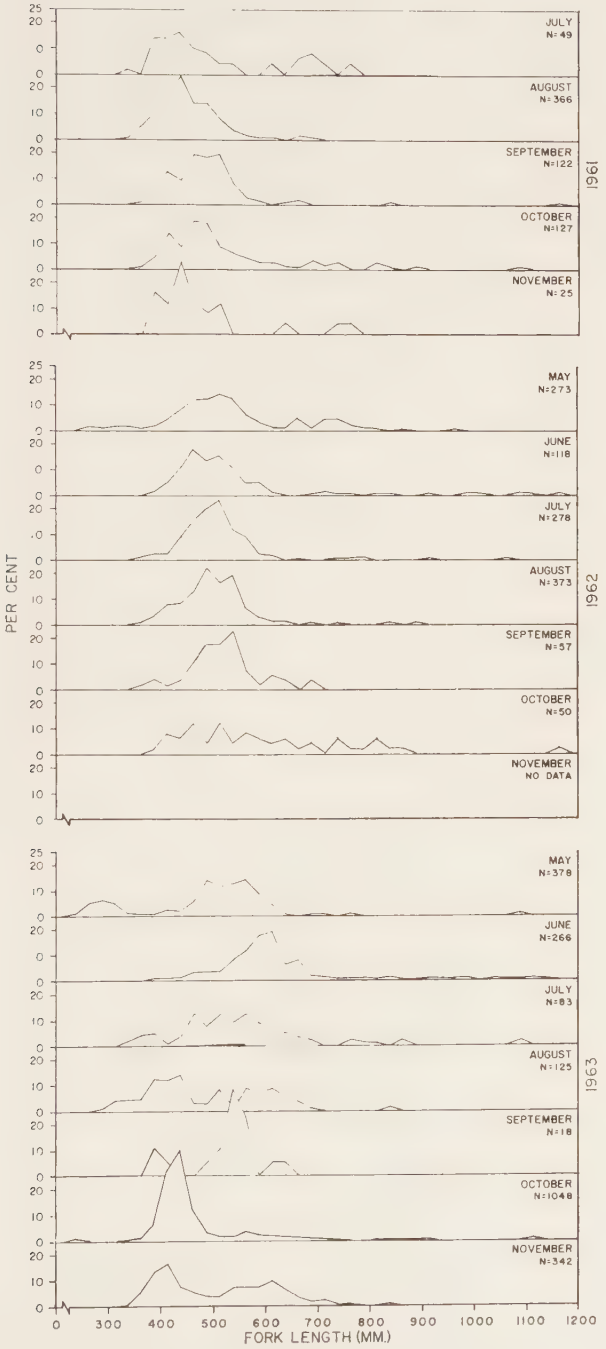


Figure 10. Monthly length-frequency distribution for striped bass taken in 1961, 1962 and 1963.

400 and 600 millimeters long. More than 70 per cent of all striped bass collected each year were in this size category, and only 4 to 12 per cent were less than 400 millimeters in length, a size which approximates the minimum legal retention limit of 16 inches in New York.

The age composition of the striped bass 600 millimeters or more in length collected in 1963 was reported by Alperin (1964). He stated that these fish ranged in age from 4 to 17 years (average of 5.9 years) and represented the year classes of 1946 through 1959. Furthermore, he indicated that 5-, 6- and 7-year-old fish comprised more than 81 per cent of this size group (5-year-old fish alone comprised more than 56 per cent), while 4-year-old fish represented about 8 per cent. Apparently all those less than 600 millimeters in length taken from the surf environment were between 2 and 5 years of age according to the age and growth data reported by Mansueti (1961).

American Shad *(Alosa sapidissima)*

The American shad, largest of the Clupeidae in the United States, ranked seventh in abundance in both 1962 (2.3 per cent of the catch) and 1963 (1.4 per cent). Like most of the other species of herring which were taken, the vast majority of American shad were captured during May and June. For example, in 1962 all but one fish, and in 1963 all but four, were collected during those months. Moreover, more than 97 per cent of the 1962 catch and 66 per cent of the 1963 catch were captured during June. The 1961 catch of only 14 was probably low because no collecting was done earlier than July 1.

Although specimens ranged in length from 140 to 560 millimeters in May of 1963, most of those taken in May and June of 1962 and 1963 were between 150 and 225 millimeters long (Figure 11). Based on data for the St. Johns, Neuse and Susquehanna Rivers (LaPointe, 1958), fish of this size were probably 1 year old. This conclusion is supported by Talbot[3] who examined scales from one of the seven specimens (230 to 270 millimeters in length) collected in November of 1961 and assigned the fish to age group I. Apparently fish larger than 225 millimeters long are mostly 2 to 6 or more years old (Borodin, 1925; LaPointe, 1958).

Windowpane *(Scopthalmus aquosus)*

The windowpane was the only representative of the Heterosomata that comprised more than 1 per cent of the catch in any year (1.2 per cent in 1961 and 1.7 per cent in 1962). It ranked eighth in abundance in 1961 and 1962 and eleventh in 1963. Windowpanes were most abundant in the spring of 1962 and 1963 when more than 90 and 85

[3] Gerald B. Talbot, personal communication.

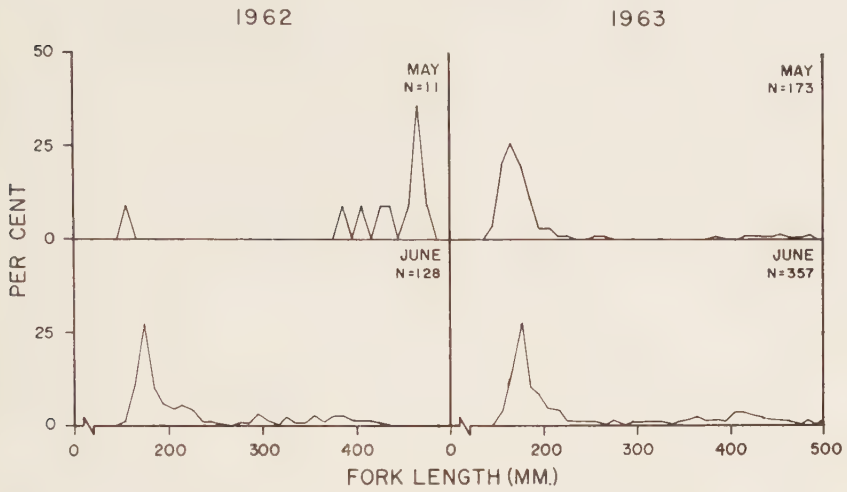


Figure 11. Monthly length-frequency distribution for American shad taken in 1962 and 1963. (Specimens over 500 millimeters long omitted for ease of presentation)

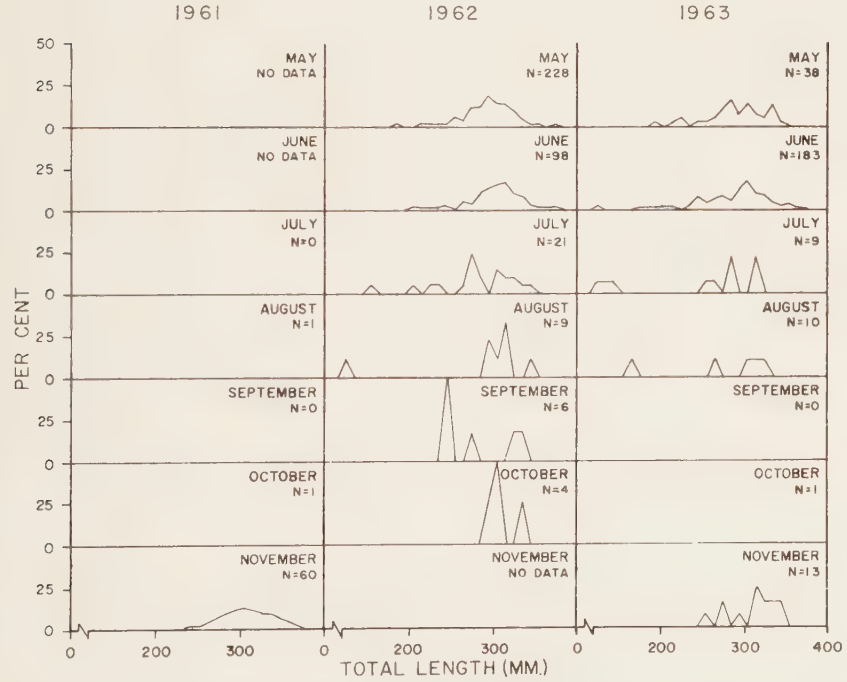


Figure 12. Monthly length-frequency distribution for windowpanes taken in 1961, 1962 and 1963. (Specimens under 120 millimeters long omitted for ease of presentation)

per cent, respectively, of the total annual catches of this fish were collected in May and June. In 1961, however, more than 95 per cent of the catch was taken in November.

Windowpanes ranged in length from 60 to 380 millimeters, but most specimens were between 250 and 350 millimeters (Figure 12). Although the collected specimens apparently ranged from 1 to more than 7 years old, the majority were probably 4 years of age or older based on data reported by Moore (1947).

Striped Searobin *(Prionotus evolans)*

The striped searobin, generally considered a nuisance species by both commercial and sport fishermen, ranked ninth in abundance in 1962 and 1963, but only sixteenth in 1961. More than 80 per cent of those seined during 1962 and 1963 were taken during July and August.

Monthly length-frequency distributions for specimens collected in 1962 and 1963 are presented in Figure 13. Although they ranged in length from 110 to 470 millimeters, most were between 250 and 400 millimeters. Almost nothing is known of the growth of this species, but Nichols and Breder (1926) suggested that "examples about 110 millimeters in October are probably a little over a year in age".

Bluefish *(Pomatomus saltatrix)*

The bluefish, one of the most popular sport fishes along the Atlantic coast, was the second most abundant species collected in 1961 when it comprised 16.3 per cent of the catch. In 1962 and 1963, however, it ranked eleventh and twelfth, respectively.

Although the bluefish collected ranged in length from 20 to nearly 700 millimeters, most specimens were less than 600 millimeters long. Furthermore, length-frequency distributions (Figure 14) indicate that several different size classes were present during most months. Specimens collected in June and July were all longer than 200 millimeters with modes generally occurring between 200 and 400 millimeters. From August through October, however, additional modes occurred below 200 millimeters and above 400 millimeters suggesting contributions of both younger and older fish to the population.

The July 1962 distribution of sizes was very similar to that of a series of specimens taken by an inshore trap net off of Belmar (N. J.) during the same month in 1951 (Hamer, 1959). The latter was composed of age groups I through IV. Moreover, Hamer also indicated that bluefish less than 250 millimeters long taken in August and September were young of the year. Apparently most of those collected in the present study ranged from less than 1 to 4 years old; possibly a few were 5 or 6 years old.

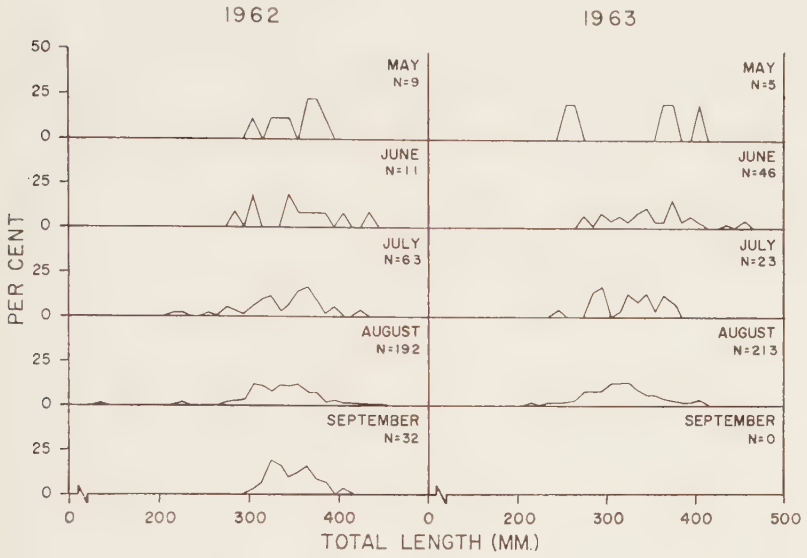


Figure 13. Monthly length-frequency distribution for striped searobins taken in 1962 and 1963. (Specimens under 120 millimeters long omitted for ease of presentation)

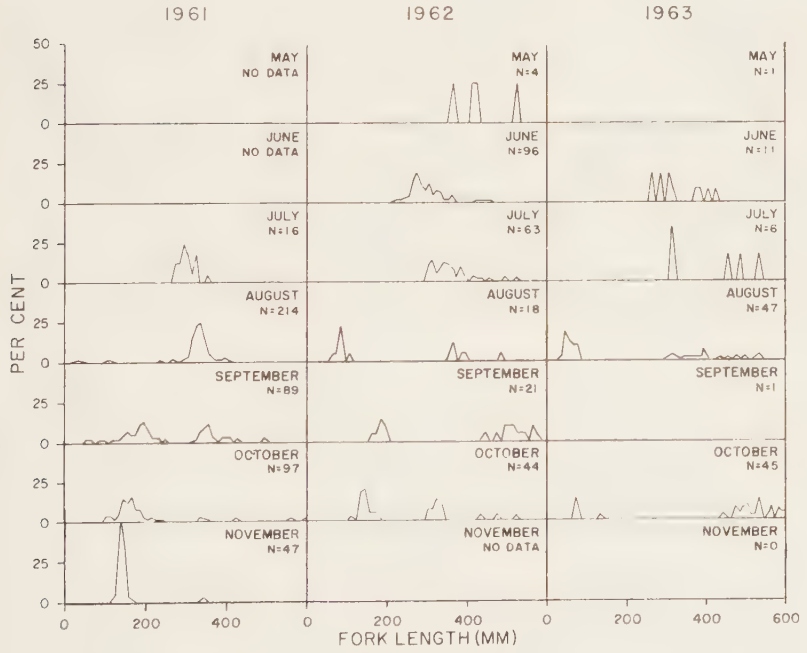


Figure 14. Monthly length-frequency distribution for bluefish taken in 1961, 1962 and 1963. (Specimens over 600 millimeters long omitted for ease of presentation)

Smooth Dogfish *(Mustelis canis)*

The smooth dogfish, a species generally considered a nuisance by all fishermen, was the only elasmobranch collected in relatively large quantities during the study. Although in 1961 only 44 were captured, 114 were taken in 1962 and 485 in 1963 when the species ranked thirteenth and eighth, respectively. Furthermore, more than 90 per cent of the 1961 catch of this species was collected during July and August, and more than 85 and 95 per cent, respectively, of the 1962 and 1963 catches were collected during June, July and August. The fish has been reported as a common summer resident in the vicinity of New York (Nichols and Breder, 1926).

Specimens ranged in length from 425 to 1,225 millimeters, but most individuals collected in 1962 and 1963 were between 500 and 700 millimeters (Figure 15). Little information is available concerning the growth of this species except that the young average about 360 millimeters in length when born, mature females are generally between 1,000 and 1,300 millimeters long, and the maximum size attained is about 5 feet (Bigelow and Schroeder, 1948, 1953).

Northern Kingfish *(Menticirrhus saxatilis)*

The northern kingfish ranked fourteenth in abundance in both 1961 and 1963, but tenth in 1962. Of all those taken during the last two years, 95 and 100 per cent, respectively, were seined during May, June and October.

Specimens ranged in length from as small as 60 to more than 400 millimeters. Those collected in May and June of 1962 and 1963 (Figure 16) were between 200 and 400 millimeters long. Schaefer (1965) reported that these fish were mostly 1 or 2 years of age. Furthermore, he indicated that more than 95 per cent of those specimens collected between August 1 and October 31 represented age groups 0, I and II.

Atlantic Menhaden *(Brevoortia tyrannus)*

This important commercial species ranked fifth in abundance in 1961 when it constituted 3.6 per cent of the total catch. It ranked fourteenth in 1962 and tenth in 1963. The months in which the largest catches were made were not consistent from year to year. For example, more than 85 per cent of the annual catch was taken in August and November of 1961, in June and July of 1962, and in May of 1963.

Specimens ranged in length from 70 to 440 millimeters. Length-frequency distributions (Figure 17) indicate that specimens taken between May and August generally exceeded 250 millimeters while

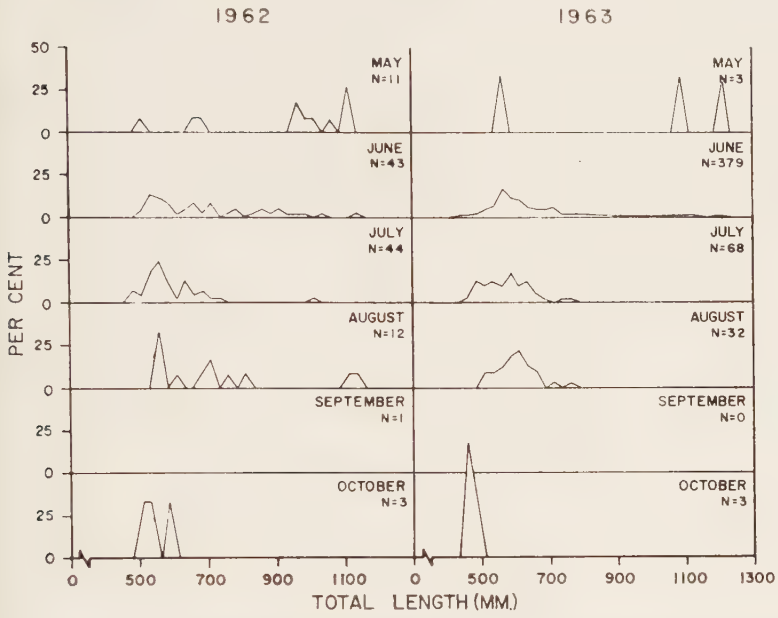


Figure 15. Monthly length-frequency distribution for smooth dogfish taken in 1962 and 1963.

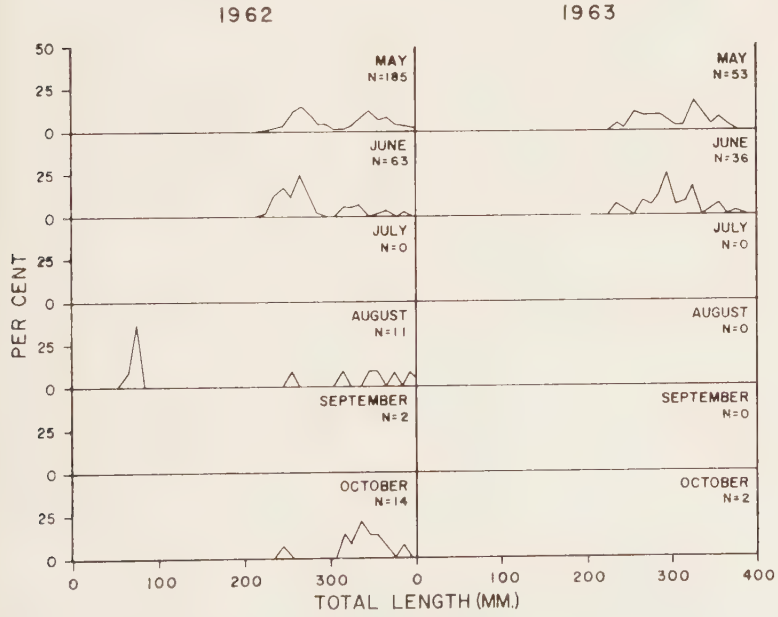


Figure 16. Monthly length-frequency distribution for northern kingfish taken in 1962 and 1963. (Specimens over 400 millimeters long omitted for ease of presentation)

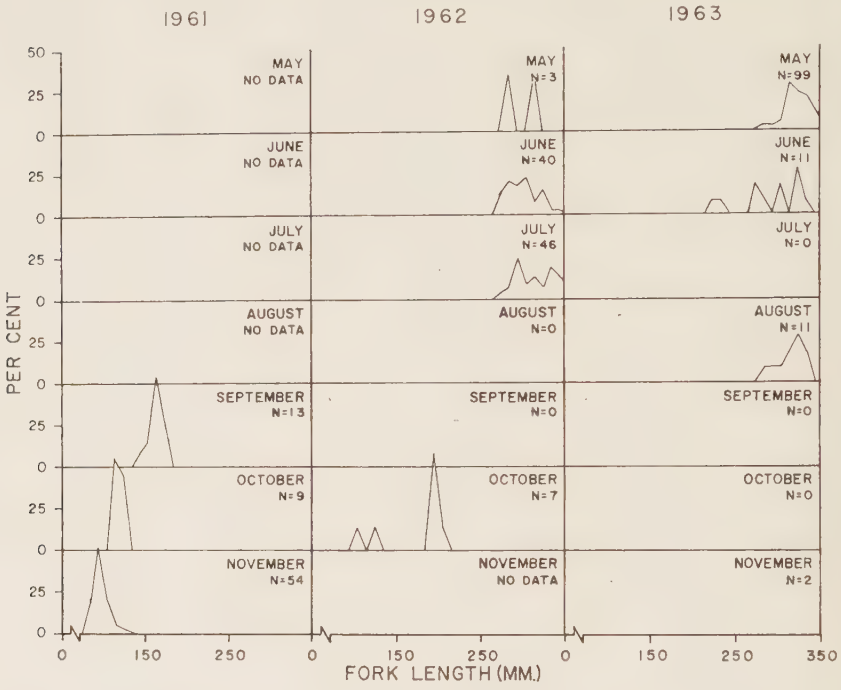


Figure 17. Monthly length-frequency distribution for Atlantic menhaden taken in 1961, 1962 and 1963. (Specimens over 350 millimeters long omitted for ease of presentation)

those taken between September and November, when the distribution exhibited several distinct modes, were smaller. The latter were most likely yearling fish, whereas the larger-sized fish probably were mostly 2 to 4 years old, based on information reported by Nicholson and Higham (1965).

Striped Mullet *(Mugil cephalus)*

Although only 15 were collected in 1962 and two in 1963, 68 specimens of this species were taken in 1961 (1.3 per cent of the catch) when the fish ranked seventh in abundance. In each year it was encountered only during September, October or November.

Lengths ranged from 180 to 260 millimeters. Modes in October of 1961 and 1962 were at 205 millimeters (Figure 18). It is possible that most of these specimens were nearing the end of their second year of life, based on information reported by Anderson (1958).

Atlantic Herring *(Clupea harengus harengus)*

A total of 59 specimens, 2 captured in October and 57 in November, were taken in 1961 (1.2 per cent of the catch) when the species

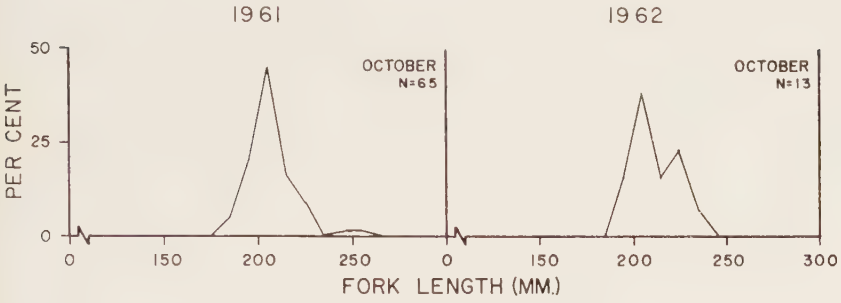


Figure 18. Length-frequency distribution for striped mullet taken during October in 1961 and 1962.

ranked ninth in abundance, but none was collected in 1962 and only six were seined in May of 1963.

Specimens ranged from 180 to 310 millimeters in length. The data show a mode at about 265 millimeters in November of 1961 (Figure 19). These fish were apparently all older than 2 years and

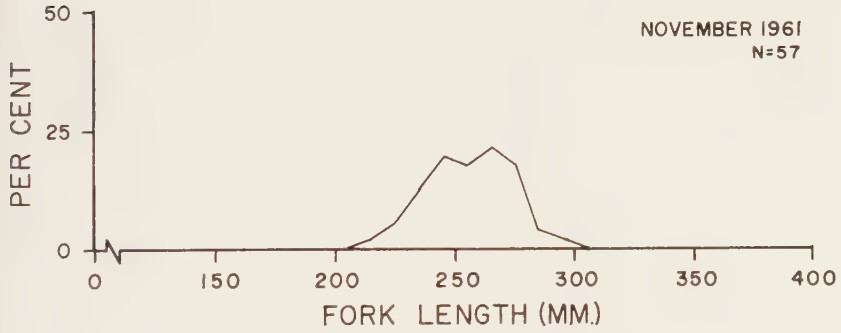


Figure 19. Length-frequency distribution for Atlantic herring taken during November in 1961.

may have included specimens as old as 10 years according to information reported by Hildebrand (1963).

Other Species.

Data for all other species collected are also presented in Tables 4, 5 and 6. Detailed information on those taken in 1962 and 1963 which were new or considered to be uncommon in Long Island waters, i.e., the cownose ray, cornetfish, African pompano, mackerel scad, rough scad, Atlantic cutlassfish, planehead filefish and smooth puffer, has been reported by Alperin and Schaefer (1965).

DISCUSSION

Reid (1955), employing a haul seine 100 feet long, reported taking only 25 species of fish from the shallow waters of the Texas Gulf coast in late June and early July of 1954, and he (Reid, 1956) reported taking 16 species at the same location in June of 1955. In the aggregate for both years 38 species were represented. Using seines 50 feet long, Gunter (1958), working over a 10-month period in three different years along the outer beach at Mustang Island in Texas, and Springer and Woodburn (1960), working monthly between September of 1957 and June of 1959 at two beach stations on the Gulf coast of Florida, reported collecting only 44 and 48 species, respectively. Even McFarland (1963), although using much larger gear, collected only 47 species over an interrupted 15-month period between May of 1960 and July of 1961. These observations suggest that fish populations inhabiting surf environments are limited to relatively few species. Indeed, Springer and Woodburn (1960) noted that their Gulf beach stations harbored fewer species than did the other habitats they sampled. They further suggested that "the beach can be considered biologically as an extreme sub-habitat of the close shore marine waters because it is an area offering comparatively little physical or chemical variety. Most of the organisms present are competing for the same few available niches". In the present study, however, 71 species were captured from the surf environment at Fire Island, 39 more than were collected either by Alperin and Schaefer (1964) at a sandy beach station inside adjacent Great South Bay or by Warfel and Merriman (1944) from a Connecticut shore on Long Island Sound. Carlisle *et al.* (1960) reported collecting 71 species from the surf in southern California.

Also, although McFarland (1963) reported capturing specimens which were all longer than 40 millimeters, the fish collected by Gunter (1958) and Springer and Woodburn (1960) were generally small. This, however, probably resulted from the small size of the collecting gear used by the latter authors. Indeed, Gunter reported collecting only 11 specimens as long or longer than 100 millimeters, while Springer and Woodburn noted the ineffectiveness of their net in taking specimens 80 millimeters or more in standard length in waters where the fish had ample room for escape. In addition, Reid (1955, 1956), although he did not give sizes for all species, reported standard lengths ranging from 20 to about 200 millimeters for fish collected at his Gulf beach station. The catches resulting from the gear used in the present study, however, indicate that specimens from as small as 20 to larger than 3,000 millimeters inhabit the surf environment off Fire Island (N. Y.).

Furthermore, although Gunter (1958) collected about 7,800 specimens in 115 hauls at outer beach stations for an average of only 68 fish per haul, Reid (1955, 1956) collected over 11,500 specimens in 43 hauls for an average of 267 per haul, and Carlisle *et al.* (1960) collected 128,000 specimens in 451 hauls for an average of 284 per haul. Nearly 68,000 specimens were captured in 188 hauls during the present study for an average of 361 per haul. These and the other observations cited would seem to indicate that, contrary to the findings of some authors, the surf environment, at least off Fire Island (N. Y.) and southern California, is inhabited by a wide variety of species and sizes of finfish in relatively large numbers.

Although the northern puffer was by far the most numerous species seined from the surf environment in 1962 and 1963 and was among the most abundant fishes in the surf sport fishery catch during the same years (Briggs, 1965a), this high level of occurrence has apparently prevailed only since 1961. Indeed, Briggs (1965a) reported that this species constituted only 5 to 16 per cent of the total sport fishery catch from three south shore surf areas in 1961, but comprised as much as 37 to 53 per cent of the catch in 1962 and 20 to 51 per cent in 1963. Moreover, Briggs (1962) recorded catches of northern puffer in Great South Bay from 1958 through 1960 which ranged between 27,000 and 58,000 individuals (0.8 to 1.9 per cent of the total catch), but he stated for the same area that "during May and June alone 95,373 were landed in 1961, and the number increased to 313,765 in 1962 and remained high (244,589) in 1963" (Briggs, 1965b). These latter catches represented 7, 26 and 30 per cent, respectively, of the total catches in Great South Bay during May and June for the 3-year period (Briggs, unpublished data). He concluded that the abundance of this species was sufficiently high in Great South Bay between 1961 and 1963 to have probably been responsible for the decline in the number of winter flounder anglers in May and June and, consequently, for the decline in the winter flounder catch.

An examination of the commercial fishery data for the northern puffer (Table 7) reveals that the catches from waters of New York and the Middle Atlantic States in 1962 and 1963 were larger than any during the preceding 10 and 14 years, respectively, while the catches in the states bordering Chesapeake Bay have suddenly increased in recent years to more than 12,000,000 pounds in 1965. Based on these records for the commercial and sport fisheries, it would appear that the present study was carried on during years when the puffer population was very high and that its relative abundance in the surf-seine catches of 1962 and 1963 was somewhat atypical of its status in most other years.

As a combined group, the herrings (Clupeidae) were the second

Table 7. Commercial Catch (in pounds) of Northern Puffer for Certain Parts of the Atlantic Coast from 1939 to 1965*

Year	New York	Middle Atlantic States§	Chesapeake States†
1939	1,000	1,000	6,000
1940	19,500	19,500	7,600
1941	‡	‡	12,500
1942	58,100	62,300	2,700
1943	60,400	61,000	‡
1944	1,634,800	1,637,300	100
1945	2,348,000	2,353,000	32,300
1946	2,012,600	‡	59,300
1947	1,495,800	1,617,400	55,000
1948	996,800	1,137,300	104,300
1949	822,800	880,600	423,500
1950	788,900	822,200	743,500
1951	812,100	865,600	687,200
1952	531,800	586,300	438,100
1953	517,000	533,000	275,000
1954	343,800	354,000	623,000
1955	146,900	167,000	487,000
1956	283,800	310,000	600,000
1957	500,400	530,000	489,000
1958	230,300	299,000	259,000
1959	138,000	194,000	831,000
1960	299,000	333,000	1,326,000
1961	492,200	566,000	1,160,000
1962	538,000	684,000	1,363,000
1963	947,700	1,116,000	2,125,000
1964	549,900	685,000	5,147,000
1965	402,500	503,000	12,242,700

* Source: Fishery Statistics of U.S. Dept. Interior.
§ New York, New Jersey and Delaware
† Maryland and Virginia.
‡ No data available.

most abundant fishes each year, comprising 22.6 per cent of the 1961 catch, 14.3 per cent of the 1962 catch, and 24.9 per cent of the 1963 catch. Together with the northern puffer, these fish constituted more than 80 per cent of the total catch in 1962 and nearly 90 per cent in 1963. Although Pearse *et al.* (1942) in North Carolina and Carlisle *et al.* (1960) in southern California found that herrings contributed little or nothing to the catch composition of their surf collections, it is of interest that both Gunter (1945, 1958) at Mustang Island in Texas and Springer and Woodburn (1960) on the Gulf Coast of Florida reported small specimens of the scaled sardine (*Harengula pensacolae*) to be among the most abundant fishes seined at outer beach stations. McFarland (1963), also working at Mustang Island, suggested that while this clupeid comprised only 2.6 per cent of all his beach seine catches, "*H. pensacolae* would constitute a considerable portion of the standing crop" had smaller-meshed gear been used.

Furthermore, Reid (1955) reported that adults of the largescale menhaden (*Brevoortia patronus*) constituted nearly 59 per cent of his collections in 1954.

Among the herrings in the surf collections, the American shad and the hickory shad are of particular interest. Both species are known to be catchable by hook and line, yet Briggs (1965a) did not observe any in the sport fishery catches from the south shore surf of Long Island. It is conceivable that each of these species, especially the hickory shad which was present in the surf environment in fairly large quantities of catchable-sized fish, could make a substantial contribution to the surf sport fishery if angling techniques were developed to take them.

Although American shad as long as 560 millimeters were captured, most specimens were between 150 and 225 millimeters and were probably yearling fish. While it has been established that most juvenile American shad vacate their rivers and estuaries of origin at the end of the first year of life and only return as sexually mature adults (Leach, 1925; Hildebrand and Schroeder, 1928; Bigelow and Schroeder, 1953), examples of intermediate-sized fish are generally lacking from oceanic collections. Borodin (1925), in his study on the age of the species, commented that "specimens of sizes 11-29 centimeters (groups II and III, age 1-3 years) are very rare and were all caught in salt water", and Barney (1925) mentioned having a collection of American shad containing only one "uncommon specimen of intermediate size" (14 centimeters) taken from Long Island Sound. Furthermore, Hildebrand (1963) stated that the "growth rate after the young have entered salt water is not well known because of the lack of specimens available for examination". Observations such as these suggest that, in terms of size and age, the catches of American shad made in the surf environment during the present study are rather unique. Apparently the surf zone provides a habitat which is suitable, possibly even preferable, to yearling and subadult American shad at certain times of the year.

Another species which might possibly make a greater contribution to the sport fishery in the surf, especially during spring and fall, is the windowpane. Although Briggs (1965a) reported that it was not represented in the catch of the surf sport fishery on the south shore of Long Island in 1961 and 1963 and comprised only a trivial percentage of the surf sport fishery catch between Jones and Fire Island Inlets in 1962, the windowpane was among the most abundant fishes seined from the surf environment during the present study. Since the species is known to feed actively on fish and invertebrates and will take a baited hook (Moore, 1947), its low occurrence in hook and line catches is apparently due to a general lack of interest by anglers

and use of fishing techniques not adapted to taking it. It is interesting that the species is not sought after more actively by surf fishermen since, although this flatfish is considered "thin" for its size and is not especially noted for its fighting characteristics on hook and line, large specimens (250 millimeters and longer) can be filleted easily and the meat is reputed to have excellent table qualities (DeKay, 1842; Nichols and Breder, 1926). Indeed, during World War II, the species comprised a rather sizeable portion of the commercial foodfish landings at New York; nearly 750,000 pounds of windowpane were brought in to this port between November 1943 and December in 1945 (Moore, 1947).

Except for the northern puffer which has constituted a large percentage of the catch since 1961, Briggs (1962, 1965a) has shown that the surf sport fishery on the south shore of Long Island is primarily dependent on three species, i.e., striped bass, northern kingfish and bluefish. The latter, generally regarded by sport fishermen to be highly desirable and are actively sought by them, were also among the most numerous species captured in the seine collections. The relative abundance in the seine catches, however, was not always reflected in the surf sport fishery catches made at the same time of year.

For example, Briggs (1965a) noted that the catch, catch per effort and proportion of total monthly catch of striped bass were generally highest in the spring (April and May) and fall (September, October and November) and lowest in the summer (June, July and August). To the contrary, however, more than 60 per cent of all striped bass seined in 1961 and 1962, and more than 20 per cent of those seined in 1963, were captured during June, July and August. Moreover, this fish never ranked lower than eighth in abundance among all species during any of these summer months. In fact, it ranked first in July and August of 1962, and second and third, respectively, in July and August of 1961. These data suggest that the striped bass, although obviously present in quantity in the surf environment during the summer, is apparently less vulnerable to hook and line angling at this time of year than in spring or fall.

Similarly, Briggs (1965a) reported that the northern kingfish, although not as important to the sport fishery in the present collecting area (Fire Island) as it was between Jones and Fire Island Inlets, was one of the species most frequently sought after and taken by anglers fishing the south shore surf of Long Island during the summer. During July alone, from 1957 to 1960, it constituted 57 to 77 per cent of the total catch between Jones and Fire Island Inlets (Briggs, 1962). Its low contribution to the surf sport fishery during spring and fall is indicated by the percentage of the annual catch that was taken between June 1 and September 30. From 82 to 98 per cent and from

88 to 95 per cent, respectively, of the annual hook and line catches of the species at Fire Island and between Jones and Fire Island Inlets were taken during this period in the years 1961 to 1963 (Briggs, 1965a). To the contrary, the numbers collected by surf seining in 1962 and 1963 were highest in spring and fall and lowest in summer. That no examples were seined in July, August and September of 1963 is surprising and remains, for the most part, inexplicable. Apparently the species is highly vulnerable to hook and line angling in the summer when it is actively sought by sport fishermen. In spring and fall, however, when it occurred in the surf environment in large numbers, fishing interest was diverted to other species such as the striped bass (Briggs, 1965a).

Little can be said to compare bluefish catches in the surf sport fishery (Briggs, 1962, 1965a) with those made by haul seining since each was characterized by wide and erratic fluctuations in numbers between months and years. These fluctuations were apparently a result of the nature of the fish to occur only sporadically in the surf environment, being present in large schools at one moment and nearly or completely absent the next. For example, of the 569 bluefish captured in August of 1961, more than 400 were taken in one haul of the seine on August 18, but none was collected in two additional hauls made on the same date. Of the remaining 18 hauls made that month, five took no bluefish at all and 13 took from as few as two to as many as 41.

Reid (1955, 1956), Gunter (1945, 1958) and McFarland (1963) found mullets *(Mugil cephalus* and/or *M. curema)* and anchovies *(Anchoa mitchilli* and/or *A. hepsetus)* to be among the most abundant fishes taken in their beach seine catches. In addition to these species, the latter two authors also collected the tidewater silverside *(Menidia beryllina)* in abundance, while Pearse *et al.* (1942) reported that the Atlantic silverside *(M. menidia)* and bay anchovy *(A. mitchilli)* were included among the most abundant fishes seined by them at outer beach stations. It is believed that such species, i.e., striped mullet, Atlantic silverside and bay anchovy, would have also been captured in greater abundance during the present study if smaller-meshed gear had been used. Indeed, these fishes, generally regarded as "forage" or "bait" species in New York, were observed to have passed through and over the net in large numbers on many occasions. Only the larger specimens were retained in the "bag".

Of passing interest was the frequent occurrence of the roughtail sting-ray in the haul seine collections during the summer. One specimen of this potentially dangerous species was the largest fish taken in the study, measuring 3,090 millimeters from tip of snout to tip of tail and 1,300 millimeters across the disc and weighing well over 100

pounds. Carlisle *et al.* (1960) and McFarland (1963) each collected at least one species of *Dasyatis* in addition to other rays in their surf studies.

Also noteworthy was the collection of one species, *Carcharius taurus*, of sand shark and two species, *Carcharhinus obscurus* and *C. milberti*, of requiem sharks from the surf environment. Although none of the specimens exceeded 1,310 millimeters (approximately 4 1/3 feet) in length, these sharks are known to attain maximum lengths of from 8 to 12 feet and weights of 200 pounds and more (Bigelow and Schroeder, 1948). While attacks on humans have definitely been attributed to *C. obscurus* and *C. taurus* (Garrick and Schultz, 1963), Randall (1963) stated that "sketches of dangerous sharks could be extended further to include the sandbar or brown shark *(C. milberti)* and others".

LITERATURE CITED

Alperin, Irwin M. 1964. Age determination of striped bass in the surf. New York Federal Aid Project F-15-R-9 (Completion report for Job B-2). N.Y.S. Cons. Dept. (unpub.)

Alperin, Irwin M., and Richard H. Schaefer. 1964. Juvenile bonefish (*Albula vulpes*) in Great South Bay, New York. N. Y. Fish and Game Jour. 11 (1) :1–12.

———————— 1965. Marine fishes new or uncommon to Long Island, New York. N. Y. Fish and Game Jour. 12 (1) :1–16.

Anderson, William W. 1958. Larval development, growth, and spawning of striped mullet (*Mugil cephalus*) along the South Atlantic coast of the United States. U. S. Fish and Wildl. Ser., Fish. Bull. 58 (144) :501–519.

Barney, R. L. 1925. A confirmation of Borodin's scale method of age determination of Connecticut River shad. In: A Report of Investigations Concerning Shad in the Rivers of Connecticut. Conn. St. Bd. Fish and Game: 52–60.

Bigelow, Henry B., and William C. Schroeder. 1948. Sharks. In: Fishes of the Western North Atlantic, No. 1, Part I. Sears Found. Marine Res., Yale Univ.: 59–546.

———————— 1953. Fishes of the Gulf of Maine. U. S. Fish and Wildl. Ser., Fish. Bull. 53 (74).

Bigelow, Henry B., and W. W. Welsh. 1925. Fishes of the Gulf of Maine. Bull. U. S. Bur. Fish. Vol. 40, Part I.

Borodin, N. 1925. Age of shad (*Alosa sapidissima* Wilson) as determined by the scales. In: A Report of Investigations Concerning Shad in the Rivers of Connecticut. Conn. St. Bd. Fish. and Game: 46–51.

Briggs, Philip T. 1962. The sport fisheries of Great South Bay and vicinity. N. Y. Fish and Game Jour. 9 (1) :1–36.

———————— 1965a. The sport fishery in the surf on the south shore of Long Island from Jones Inlet to Shinnecock Inlet. N. Y. Fish and Game Jour. 12 (1) :31–47.

———————— 1965b. The sport fisheries for winter flounder in several bays of Long Island. N. Y. Fish and Game Jour. 12 (1) :48–70.

Carlisle, John G., Jr., Jack W. Schott and Norman J. Abramson. 1960. The barred surfperch (*Amphistichus argenteus* Agassiz) in southern California. Calif. Dept. Fish and Game, Fish Bull. 109.

DeKay, James E. 1842. Zoology of New York. Part IV. Fishes. White and Visscher, Albany.

deSylva, Donald P., Frederick A. Kalber, Jr., and Carl N. Shuster, Jr. 1962. Fishes in the shore zone and other areas of the Delaware River estuary. Univ. Del. Marine Lab. Inform. Ser., Pub. 5.

Garrick, J. A. F., and Leonard P. Schultz. 1963. A guide to the kinds of potentially dangerous sharks. In: Sharks and Survival. D. C. Heath and Co., Boston: 3–60.

Gordon, Malcolm S. 1949. One summer's survey of shallow-water fishes at Coney Island, New York. Marine Life, Occas. Papers 1 (7) :23–34.

Greeley, John R. 1939. Fishes and habitat conditions of the shore zone based upon July and August seining investigations. In: A Biological Survey of the Salt Waters of Long Island, 1938. Part II. N.Y.S. Cons. Dept.: 72–91.

Gunter, Gordon. 1945. Studies on marine fishes of Texas. Publ. Inst. Marine Sci. Univ. Tex. 1 (1) :1–190.

———————— 1958. Population studies of the shallow water fishes of an outer beach in south Texas. Publ. Inst. Marine Sci. Univ. Tex. 5:186–193.

Hamer, Paul E. 1959. Age and growth studies of the bluefish (*Pomatomus saltatrix* Linnaeus) of the New York Bight. M.S. thesis, Rutgers Univ. Library.

Helle, James R. 1958. Surf statistics for the coasts of the United States. Corps. U. S. Army Eng., Beach Erosion Bd., Tech. Memo. 108.

Hildebrand, Samuel F. 1963. Family Clupeidae. In: Fishes of the Western North Atlantic, No. 1, Part III. Sears Found. Marine Res., Yale Univ.:257–454.

Hildebrand, Samuel F., and William C. Schroeder. 1928. Fishes of Chesapeake Bay. Bull. U. S. Bur. Fish. Vol. 13, Part I.

LaPointe, Donald F. 1958. Age and growth of the American shad, from three Atlantic coast rivers. Trans. Amer. Fish. Soc. 87 (1) :139–150.

Leach, Glen C. 1925. Artificial propogation of shad. Rept. U. S. Comm. Fish. 1924:459–486.

Mansueti, Romeo J. 1961. Age, growth, and movements of the striped bass, *Roccus saxatilis,* taken in size selective fishing gear in Maryland. Ches. Sci. 2 (1-2) :9–36.

———— ———— 1962. Eggs, larvae, and young of the hickory shad, *Alosa mediocris,* with comments on its ecology in the estuary. Ches. Sci. 3 (3) :173–205.

McFarland, William N. 1963. Seasonal change in the number and the biomass of fishes from the surf at Mustang Island, Texas. Publ. Inst. Marine Sci. Univ. Tex. 9:91–105.

Moore, Emmeline. 1947. Studies on the marine resources of southern New England. VI. The sand flounder, *Lophopsetta aquosa* (Mitchilli) ; a general study of the species with special emphasis on age determination by means of scales and otoliths. Bull. Bing. Ocean. Coll. 11 (3) :1–79.

Nichols, John T., and Charles M. Breder, Jr. 1926. The marine fishes of New York and southern New England. Zoologica 9 (1) :1–192.

Nicholson, William R., and Joseph R. Higham, Jr. 1965. Age and size composition of the menhaden catch along the Atlantic coast of the United States, 1961, with a brief review of the commercial fishery. U. S. Fish and Wildl. Ser. Sp. Sci. Rept., Fish. No. 495.

Pearse, A. S., H. L. Humm and G. W. Warton. 1942. Ecology of sand beaches at Beaufort, North Carolina. Ecol. Mono. 12 (2) :135–190.

Randall, John E. 1963. Dangerous sharks of the western Atlantic. In: Sharks and Survival. D. C. Heath and Co., Boston:339–361.

Reid, George K. 1955. A summer study of the biology and ecology of East Bay, Texas. Part II. Tex. Jour. Sci.:7 (4) : 130–153.

———————— 1956. Observations on the eulittoral ichthyofauna of the Texas Gulf coast. Southwest. Nat. 1 (4) :157–165.

Schaefer, Richard H. 1965. The age and growth of the northern kingfish in New York waters. N. Y. Fish and Game Jour. 12 (2) :191–216.

Snyder, Dana P. 1963. A report on a natural history reconnaissance of Fire Island and adjacent barrier beaches. Report prepared for National Park Service. (mimeo.)

Springer, Victor G., and Andrew J. McErlean. 1962. Seasonality of fishes on a south Florida shore. Bull. Marine Sci. Gulf and Carib. 12 (1) :39–60.

Springer, Victor G., and Kenneth D. Woodburn. 1960. An ecological study of the fishes of the Tampa Bay area. Fla. St. Bd. Cons. Marine Lab. Prof. Paper Ser. No. 1.

Warfel, Herbert E., and Daniel Merriman. 1944. Studies on the marine resources of southern New England. I. An analysis of the fish population of the shore zone. Bull. Bing. Ocean. Coll. 9 (2) :1–91.

DISTRIBUTION AND ABUNDANCE OF FISH ALONG THE SHORES OF THE LOWER HUDSON RIVER DURING THE SUMMER OF 1965[1]

Alfred Perlmutter — Professor of Biology, New York University

Eugene E. Schmidt — Instructor of Biology, New York University

Eugene Leff — Instructor of Biology, Pace College

ABSTRACT

On the premise that young-of-the-year fish, which frequent shallow-water areas, would be better indicators of annual fluctuations in pollution than older fish, seining operations were carried on at nine stations along the shore of the lower Hudson River during the summer of 1965. Each station was visited five times in the period from June 21 through August 16. Most common in the catch were the spottail shiner, freshwater killifish, white perch, saltwater killifish, common silverside, Johnny darter, blueback herring, shad, alewife, bay anchovy, white mullet, tidewater silverside, goldfish, carp, golden shiner, common sunfish, striped bass and American eel. The specimens taken were preponderantly young of the year. Population composition in the euryhaline environment south of Poughkeepsie was compared with that in the fresh water area upstream. The levels of abundance recorded should serve as standards for comparison in subsequent years.

The Hudson River has supported an active commerce and commercial fisheries since its discovery, and over the years it has served as a disposal area for the sewage of towns and cities along its course. Its waters also have been used to some extent for recreational purposes (swimming, fishing and boating) and to a lesser degree for drinking and as a coolant in power and other industrial plants.

At present, after a period of neglect extending back to colonial days, attention has been focused on the Hudson River as a national resource. The awakened interest has been stimulated by problems arising from a rapid increase in population in the vicinity of the river and from technological developments in industry and agriculture. These have resulted in qualitative and quantitative changes in pollutants entering the river which could affect the aquatic biota, including fish. At the same time, the need for water of high quality for domestic and industrial use has increased. Further, with an ever increasing population, development of the river as a recreational area becomes imperative.

Unquestionably, further development of the Hudson River as a national resource will entail multiple use. A program for optimum

[1] This study was supported by Contract PH 86-65 Neg. 141, Division of Radiological Health, Bureau of State Services, U. S. Public Health Service.

multiple use will require information from many disciplines including the biological, economic and social. Information on the fish and fisheries is fragmentary and discontinuous. The most comprehensive reports on the subject are the biological studies of the Hudson River watershed made in the summers of 1932, 1934 and 1936 by the New York State Conservation Department (1933, 1935, 1937). But the information provided by these surveys applies chiefly to the few years in which they were conducted. More continuous information, particularly on the commercial fishes and fisheries of the river, are contained in annual reports of the fishery statistics of the United States compiled by the U. S. Fish and Wildlife Service (Fiedler, 1932–1941 and 1942–1945; Anderson and Power, 1946–1957; Power, 1958–1963). Individual studies have been made on certain relationships of some species, notably the shad (Talbot, 1954) and the striped bass (Rathjen and Miller, 1957).

OBJECTIVES AND METHODS

The present study has been concerned mainly with a single aspect, the biota of the river, with particular emphasis on the fish. Its objective was to determine in greater detail their distribution, size and age composition, and abundance for use as a measure of the effects of urban, agricultural and industrial pollutants on the fish populations.

The surveys of the State Conservation Department and the authors' own observations indicate that the young-of-the-year fish of many species are heavily concentrated along the shores of the river. Since these would most likely be the product of local spawning and resident in the area of birth for a large part of the period studied, it was felt that they would be better indicators of annual fluctuations in population than older fish. The older fish found in the more offshore and deeper waters of the river would consist of a mixture of year classes and be composed of both resident and immigrant individuals of unknown and changing proportions.

During the summer of 1964, a preliminary ecological study of the Hudson River was carried out in the area from Dobbs Ferry to Poughkeepsie (Eisenbud *et al.*, 1965). The fish population was sampled by seining along the shores at localities suitable for the purpose. Twelve sampling stations were established, eight on the west side and four on the east side of the river (Figure 1). Collections were made from June 23 through August 12. Included with the fish were samples of invertebrates and aquatic plants.

In the 1964 study, sampling was qualitative with no attempt being made to determine the relative abundance of the fish by locality, species or age group. The primary purpose of this initial investigation was to obtain large enough samples of the major species of fish and associ-

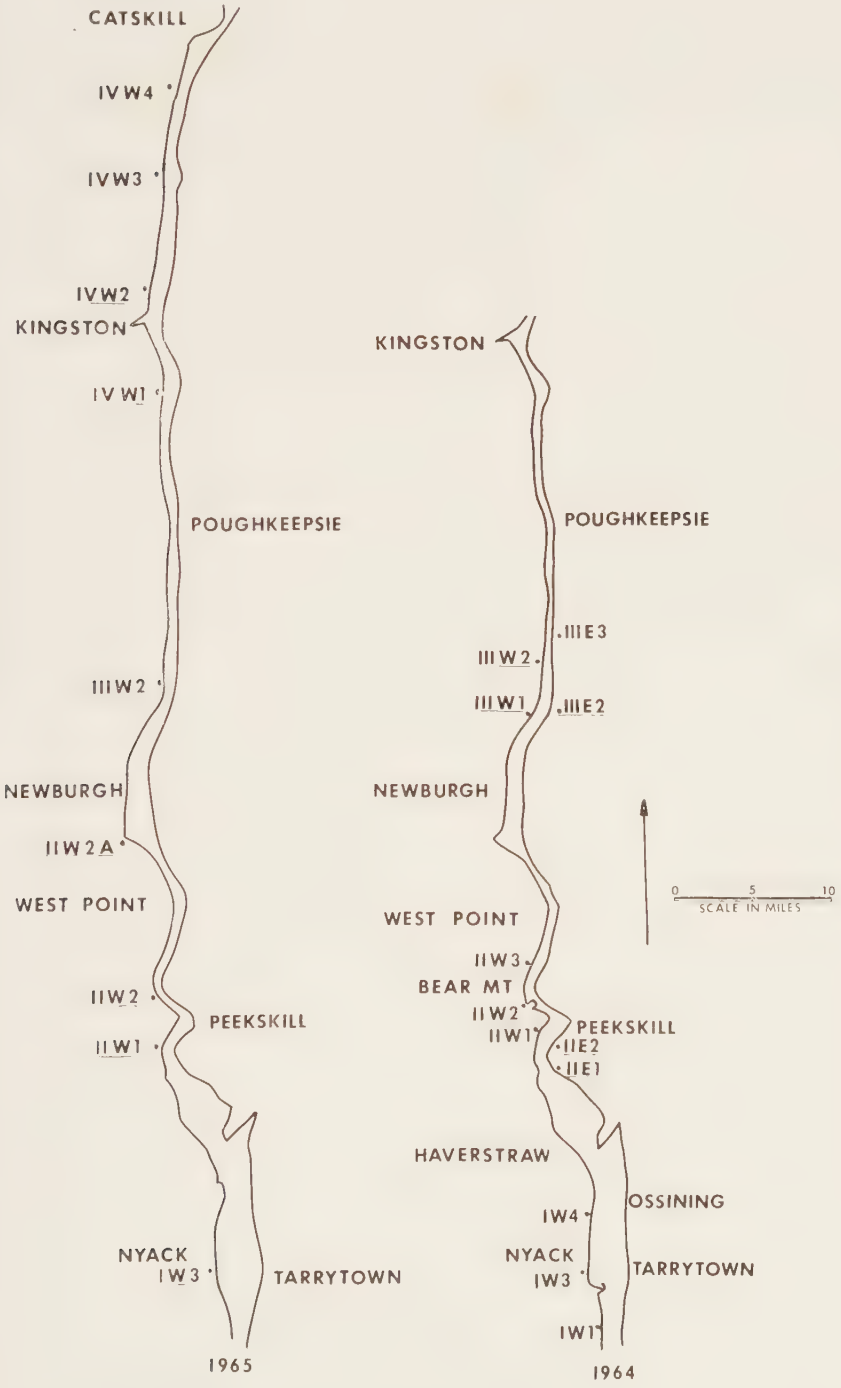


Figure 1. Location of sampling stations on the Hudson River in 1964 and 1965.

ated biota in the area below Poughkeepsie to elucidate the relationship between the levels of radioactivity in the various portions of the ecosystem. While accomplishing this primary purpose, considerable data were obtained on the general distribution of various organisms, particularly the fish along the shores.

Eleven species of fish were most frequently taken, i.e., striped bass *(Roccus saxatilis),* white perch *(Roccus americanus),* saltwater killifish *(Fundulus heteroclitus),* freshwater killifish *(Fundulus diaphanus),* shad *(Alosa sapidissima),* alewife *(Alosa pseudoharengus),* blueback herring *(Alosa aestivalis)* common sunfish *(Lepomis gibbosus),* Johnny darter *(Etheostoma nigrum),* spottail shiner *(Notropis hudsonius)* and northern silverside *(Menidia menidia).* In addition, 22 other species were taken occasionally.

During the summer of 1965, the investigation was expanded to include a section of the river above Poughkeepsie. To accomplish this with the facilities available, all collecting sites on the east side and Stations I W 1, I W 4, II W 3 and III W 1 on the west side were dropped. A new station (II W 2A) was added on the west side below Poughkeepsie at Cornwall, and four were added on the west side above Poughkeepsie. These were IV W 1, one-quarter mile north of Esopus Meadows Point; IV W 2, a cove at Ulster Landing; IV W 3, 1,500 feet northwesterly of Esopus Creek Inlet; and IV W 4, the cove 1,000 feet south of Smith Landing at Cementon (Figure 1). Also in the 1965 study, quantitative data were recorded.

Each station was visited five times in the period from June 21 through August 16: in June on one day during the interval June 21–22; in July on one day each during the intervals July 6–7 and July 19–20; and in August on one day each during the intervals August 2–4 and August 16–17. A 50-foot nylon seine of the following specifications was employed to collect the fish. The mesh size was ⅜ inch, while the top and bottom lines were of ¼-inch polypropylene. The former had plastic floats (2½ inches in diameter and 1¼ inches thick) every 15 inches, while the latter had a #9 oblong lead every 15 inches. Centrally located in the body of the net was a pocket of the same material that was 4 by 4 feet at its attachment and extended back for 6 feet.

The net was set at each station according to a fixed procedure. It was pulled out into the water perpendicular to the shore until a depth of about 4 feet was reached. The distance to this depth from the shoreline varied from station to station and changed with the tide. Measurements were made in multiples of 25 feet and ranged from 25 to 100 feet. At the prescribed position, the net was stretched parallel to the shore and then hauled to the beach. The product of the distance from the shore where the net was set and the length of the net

was taken as the area seined. Slight changes in these parameters occasionally were incurred because of obstructions. The number of tows made at a station at a particular time depended on the extensive-

TABLE 1. NUMBERS OF TOWS AND COMPUTED AREA (IN SQUARE FEET) SEINED AT EACH STATION

Station	June 21–22	July 6–7	July 19–20	August 2–4	August 16–17	Total
South of Poughkeepsie						
I W 3						
Number of tows	4	4	2	2	2	14
Total area	13,750	16,750	7,500	6,250	6,750	51,000
Average per tow	3,438	4,188	3,750	3,125	3,375	3,600
II W 1						
Number of tows	2	2	2	4	3	13
Total area	5,000	5,000	5,750	4,500	5,500	25,750
Average per tow	2,500	2,500	2,875	1,125	1,833	2,000
II W 2						
Number of tows	2	2	2	3	2	11
Total area	2,675	2,500	1,375	1,875	4,500	12,925
Average per tow	1,338	1,250	688	625	2,250	1,200
II W 2A						
Number of tows	2	2	2	3	2	11
Total area	6,250	10,000	7,500	10,000	7,500	41,250
Average per tow	3,125	5,000	3,750	5,000	3,750	3,800
III W 2						
Number of tows	4	2	2	4	3	15
Total area	10,000	5,000	5,000	12,500	9,250	41,750
Average per tow	2,500	2,500	2,500	3,125	3,083	2,800
North of Poughkeepsie						
IV W 1						
Number of tows	3	2	2	2	2	11
Total area	13,750	7,500	7,500	12,500	5,000	46,250
Average per tow	4,583	3,750	3,750	6,250	2,500	4,200
IV W 2						
Number of tows	3	3	3	3	3	15
Total area	8,750	8,750	11,250	15,000	13,750	57,500
Average per tow	2,917	2,917	3,750	5,000	4,583	3,800
IV W 3						
Number of tows	3	3	3	2	2	13
Total area	8,750	4,250	10,000	7,500	10,000	40,500
Average per tow	2,917	1,417	3,333	3,750	5,000	3,100
IV W 4						
Number of tows	4	2	5	3	2	16
Total area	7,500	5,000	17,500	13,750	7,500	51,250
Average per tow	1,875	2,500	3,500	4,583	3,750	3,200

ness of the shore area suitable for seining which varied according to the tide. Table 1 summarizes the number of tows made at each station and the computed total area seined. The average total area seined per station for the entire period studied was 40,908 square feet and ranged from 12,925 square feet at Station II W 2 to 57,500 square feet at Station IV W 2. The average number of tows made at the individual stations was 13 with a range of 11 to 16.

For each species the lengths of the specimens taken at Stations I W 3, II W 1, II W 2, II W 2A and III W 2 were pooled, and the composite length frequency was considered indicative of the size composition for that species in the euryhaline environment below Poughkeepsie. Similarly, lengths taken at Stations IV W 1, IV W 2, IV W 3 and IV W 4 were combined, and the pooled frequency was taken as indicative of size in the freshwater environment above Poughkeepsie. Further, the combined frequencies by species for the areas below and above Poughkeepsie were determined, when possible, for two time periods, namely, June-July (Period 1) and August (Period 2).

From these length frequencies, together with information on length-age distributions obtained in the 1964 study (Eisenbud *et al.*, 1965), the catch of most species could be divided into two age categories: a 0+ (young of the year) group and a I+ or older group. This information was then correlated with field data on the extent of area seined. An arbitrary relative catch-per-unit-of-area figure, i.e., the number of fish caught in each of the two age categories per 100,000 square feet of shore area seined, was calculated for each station during each collection interval throughout the season. This measure of relative abundance and availability was also calculated for each species for the entire collecting period and for the whole river by taking the average of the catch per 100,000 square feet of shore area seined for all nine stations.

RESULTS

A total of 18 species were most common in the catch. These were the white perch, striped bass, shad, alewife, blueback herring, spottail shiner, goldfish (*Carassius auratus*), carp (*Cyprinus carpio*), golden shiner (*Notemigonus crysoleucas*), saltwater killifish, freshwater killifish, Johnny darter, common sunfish, American eel (*Anguilla rostrata*), northern silverside, tidewater silverside (*Menidia beryllina*), bay anchovy (*Anchoa mitchilli*) and white mullet (*Mugil curema*). Appearing as rare stragglers, particularly in the area below Poughkeepsie, were the bluefish (*Pomatomus saltatrix*), tomcod (*Microgadus tomcod*), northern pipefish (*Syngnathus fuscus*), four-spined stickleback (*Apeltes quadracus*), hogchocker (*Trinectes maculatus*), Atlantic needlefish (*Strongylura marina*) and crevalle jack (*Caranx hippos*).

Length-frequency Distribution

The length-frequency distributions of these species are given in Tables 2–7. To facilitate analysis, the length frequencies have been plotted for the 12 species that were most abundant or of economic importance or both (Figures 2–6). Where sufficient data were avail-

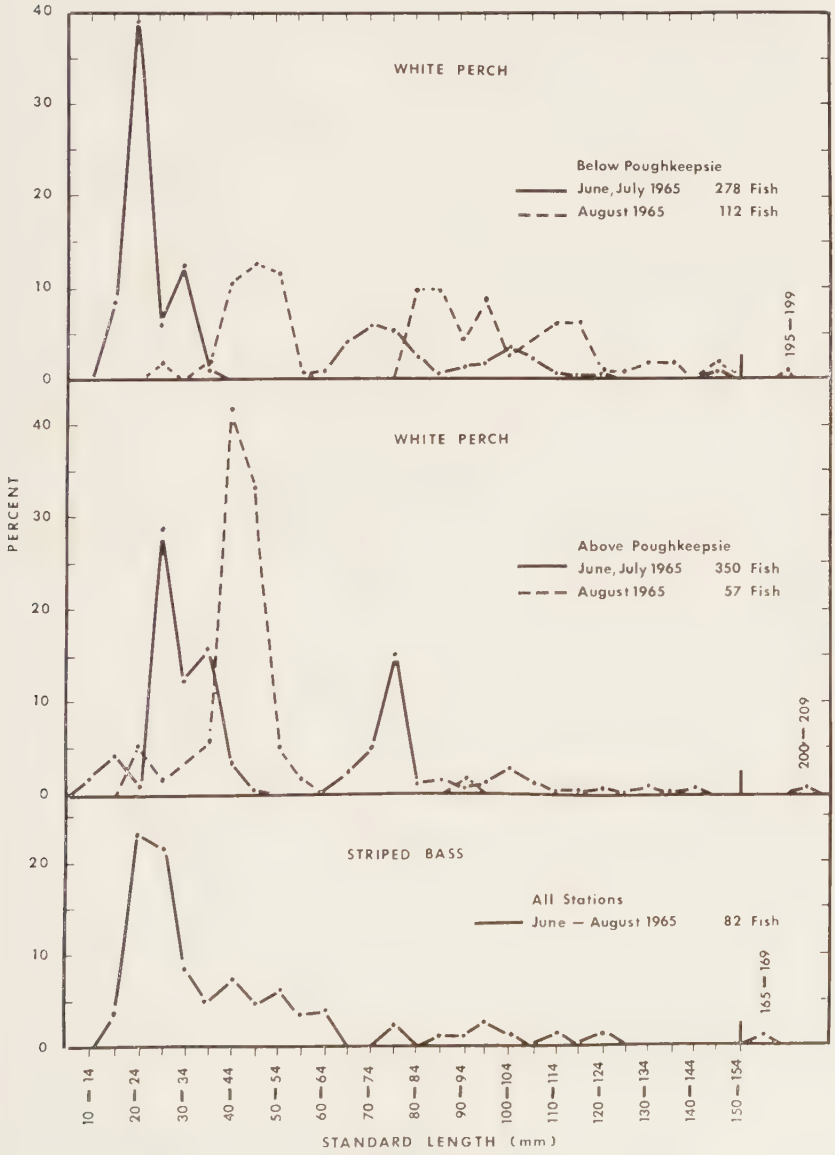


Figure 2. Length-frequency distribution for white perch and striped bass.

Table 2. Length-frequency Distribution Recorded for White Perch, Striped Bass and American Eel

Standard length (millimeters)	White perch								Striped bass		American eel			
	South of Poughkeepsie				North of Poughkeepsie				All stations (both periods)		South of Poughkeepsie (both periods)		North of Poughkeepsie (both periods)	
	Period 1		Period 2		Period 1		Period 2							
	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent
10–14	..	..	..	..	6	1.7	..	..	..	..	..	..	..	..
15–19	24	8.6	..	..	15	4.3	..	..	3	3.7	..	..	..	..
20–24	110	39.6	..	..	3	0.9	3	5.3	19	23.2	..	..	..	..
25–29	17	6.1	2	1.8	102	29.1	1	1.8	18	22.0	..	..	..	..
30–34	34	12.2	..	..	43	12.3	2	3.5	7	8.5	..	..	..	..
35–39	3	1.1	2	1.8	55	15.7	3	5.3	4	4.9	..	..	..	..
40–44	..	..	12	10.7	12	3.4	24	42.1	6	7.3	..	..	..	..
45–49	..	..	14	12.5	1	0.3	19	33.3	4	4.9	..	..	..	..
50–54	..	..	13	11.6	..	..	3	5.3	5	6.1	..	..	..	..
55–59	1	0.4	1	0.9	..	..	1	1.8	3	3.7	..	..	..	..
60–64	3	1.1	..	..	1	0.3	..	..	3	3.7	1	1.5	..	..
65–69	12	4.3	..	..	8	2.3	..	..	..	..	6	9.2	1	3.1
70–74	17	6.1	..	..	17	4.9	..	..	..	..	10	15.4	..	..
75–79	15	5.4	..	..	53	15.1	..	..	2	2.4	6	9.2	..	..
80–84	7	2.5	11	9.8	4	1.1	..	..	..	..	7	10.8	1	3.1
85–89	2	0.7	11	9.8	5	1.4	..	..	1	1.2	2	3.1	1	3.1
90–94	4	1.4	5	4.5	2	0.6	1	1.8	1	1.2	1	1.5	..	..
95–99	5	1.8	10	8.9	4	1.1	..	..	2	2.4	3	4.6	2	6.3
100–104	9	3.2	3	2.7	9	2.6	..	..	1	1.2	3	4.6	..	..
105–109	7	2.5	5	4.5	4	1.1	..	..	..	..	3	4.6	2	6.3
110–114	2	0.7	7	6.2	1	0.3	..	..	1	1.2	1	1.5	1	3.1
115–119	1	0.4	7	6.2	..	..	..	..	..	..	2	3.1	3	9.4
120–124	1	0.4	1	0.9	1	0.3	..	..	1	1.2	3	4.6	..	..
125–129	..	..	1	0.9	..	..	..	..	..	..	1	1.5	..	..
130–134	..	..	2	1.8	2	0.6	..	..	..	..	2	3.1	3	9.4

135–139	..	..	2	1.8	..	..	..	..	..	..	..	..	..	..
140–144	1	0.4	..	..	1	0.3	..	..	..	..	2	3.1	1	3.1
145–149	2	0.7	2	1.8	..	..	..	..	..	..	..	..	..	..
150–154	1	0.4	..	..	..	..	..	..	..	..	3	4.6	1	3.1
155–159	..	..	..	..	..	..	..	..	..	..	..	..	..	..
160–164	..	..	..	..	..	..	..	..	..	..	2	3.1	5	15.6
165–169	..	..	..	..	..	..	..	..	1	1.2	1	1.5	1	3.1
170–174	..	..	..	..	..	..	..	..	..	..	1	1.5	1	3.1
175–179	..	..	..	..	..	..	..	..	..	..	1	1.5	..	..
180–184	..	..	..	..	..	..	..	..	..	..	..	..	1	3.1
185–189	..	..	..	..	..	..	..	..	..	..	..	..	1	3.1
190–194	..	..	..	..	..	..	..	..	..	..	..	..	..	..
195–199	..	..	1	0.9	..	..	..	..	..	..	..	..	..	..
200–204	..	..	..	..	1	0.3	..	..	..	..	..	..	..	..
205–209	..	..	..	..	..	..	..	..	..	..	1	1.5	..	..
210–214	..	..	..	..	..	..	..	..	..	..	1	1.5	..	..
275–279	..	..	..	..	..	..	..	..	..	..	..	..	1	3.1
305–309	..	..	..	..	..	..	..	..	..	..	..	..	1	3.1
340–344	..	..	..	..	..	..	..	..	..	..	..	..	1	3.1
380–384	..	..	..	..	..	..	..	..	..	..	..	..	1	3.1
450–454	..	..	..	..	..	..	..	..	..	..	..	..	1	3.1
Total	278	100.0	112	100.0	350	100.0	57	100.2	82	100.0	65	99.6	32	99.8

able, the length-frequency distribution has been given independently for the areas above and below Poughkeepsie both for Period 1 and Period 2. Where the data were less complete for certain species, the length-frequency information for the two areas or two periods or both were combined. An examination of these data indicates, for most species, a concentration of fish of the smaller sizes and in the 0+ age group.

For the white perch during Period 1, the fish caught ranged in length from 10 to 154 millimeters. The 0+ age group, ranging from 10 to 49 millimeters in length, comprised 68 per cent of the catch. In the northern area, the modal length was 25–29 millimeters compared with 20–24 millimeters in the southern area (Table 2 and Figure 2). The 1+ or older group ranged in length from 55 to 89 millimeters and made up 25 per cent of the catch. Once again, the fish in the northern area appeared to be larger than those in the southern area. The difference in size between the two areas was not evident in Period 2.

Data on the striped bass were not extensive enough to permit more than a calculation of the length-frequency distribution for the entire river for the total sampling period (Table 2 and Figure 2). The 0+ age group ranged from 15 to 64 millimeters in length.

Among the herrings, only the shad was found in sufficient quantities both in the northern and southern areas to compare its size composition during the two time intervals. All the shad were young of the year and ranged in length from 25 to 54 millimeters in Period 1 and from 35 to 59 millimeters in Period 2 (Table 3 and Figure 3). There was some suggestion that the fish in the northern area were larger than those in the southern area. All alewives and blueback herring were young of the year.

Since relatively few alewives and blueback herring were taken below Poughkeepsie, the total catch for the river was combined (Table 3 and Figure 3). In Period 1, the alewives in the 0+ age group were smaller than the shad and had a range of 10–59 millimeters but a mode at only 25–29 millimeters. This was also true for the blueback herring which ranged from 15 to 44 millimeters, also with a peak at only 25–29 millimeters. A relatively small sample of alewives caught in Period 2 were larger than shad taken in the same period. The blueback herring remained smaller than the shad.

Among the killifishes, the freshwater killifish in the 0+ age group had a modal length during Period 1 of 15–19 millimeters in the southern area and 20–24 millimeters in the northern area (Table 4 and Figure 4). In Period 2, the 0+ fish in the northern area were also larger in size than those in the southern area, with modes at 30–34 millimeters and 25–29 millimeters, respectively. The length-frequency

Table 3. Length-frequency Distribution Recorded for Shad, Alewife and Blueback Herring

Standard length (millimeters)	Shad								Alewife				Blueback herring			
	South of Poughkeepsie				North of Poughkeepsie				All stations				All stations			
	Period 1		Period 2		Period 1		Period 2		Period 1		Period 2		Period 1		Period 2	
	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent
10–14	..	..	..	..	..	..	..	..	9	6.1	..	..	..	..	[1]	1.3
15–19	..	..	..	..	..	..	..	..	14	9.5	..	..	4	1.3	38	12.7
20–24	..	..	..	..	..	..	..	..	25	17.0	..	..	40	12.9	33	11.0
25–29	..	..	..	..	5	6.3	..	..	39	26.5	..	..	144	46.6	56	18.7
30–34	20	39.2	..	..	21	26.3	..	..	13	8.8	..	..	103	33.3	89	29.7
35–39	7	13.7	28	68.3	31	38.8	3	3.9	17	11.6	..	..	17	5.5	66	22.0
40–44	9	17.6	12	29.3	19	23.8	14	18.2	21	14.3	..	..	1	0.3	12	4.0
45–49	12	23.5	1	2.4	4	5.0	27	35.1	4	2.7	1	5.6	..	..	2	0.7
50–54	3	5.9	..	..	..	..	26	33.8	4	2.7	1	5.6	..	..	..	..
55–59	..	..	..	..	..	..	7	9.1	1	0.7	4	22.2	..	..	..	..
60–64	..	..	..	..	..	..	..	..	..	..	6	33.3	..	..	..	..
65–69	..	..	..	..	..	..	..	..	..	..	5	27.8	..	..	..	..
70–74	..	..	..	..	..	..	..	..	..	..	1	5.6	..	..	..	..
Total	51	99.9	41	100.0	80	100.2	77	100.1	147	99.9	18	100.1	309	99.9	300	100.1

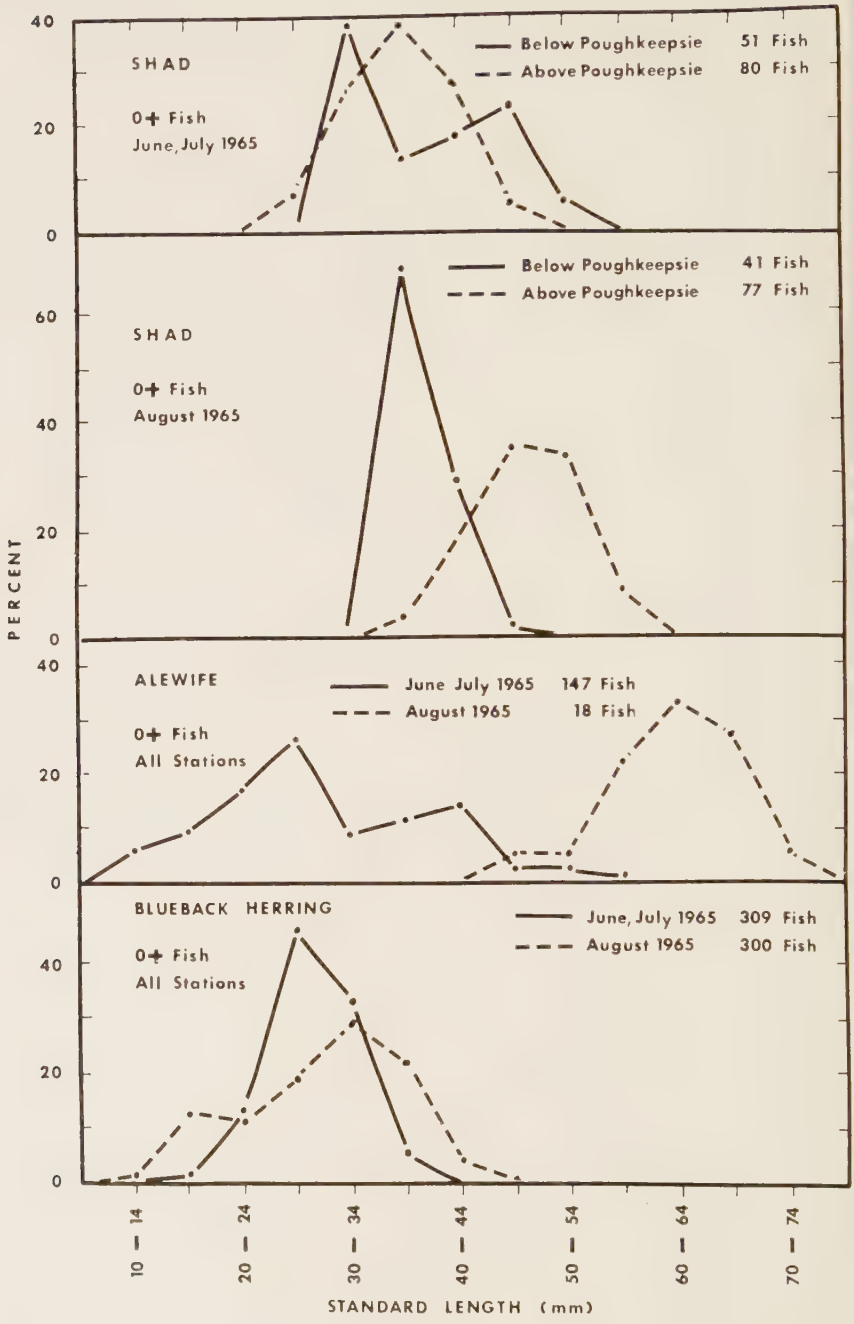


Figure 3. Length-frequency distribution for shad, alewife and blueback herring.

TABLE 4. LENGTH-FREQUENCY DISTRIBUTION RECORDED FOR FRESHWATER KILLIFISH

Standard length (millimeters)	Period 1*						Period 2*					
	Immature		Mature				Immature		Mature			
			Male		Female				Male		Female	
	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent
South of Poughkeepsie												
10–14	26	4.2										
15–19	107	17.4					3	1.1				
20–24	60	9.8					33	12.0				
25–29	13	2.1					99	35.9				
30–34	8	1.3					49	17.8				
35–39	1	0.2					10	3.6			2	0.7
40–44			6	1.0	1	0.2					4	1.4
45–49			24	3.9	13	2.1	1	0.4	1	0.4	4	1.4
50–54			33	5.4	28	4.6			3	1.1		
55–59			71	11.6	36	5.9			8	2.9	3	1.1
60–64			37	6.0	47	7.7			13	4.7	12	4.3
65–69			28	4.6	23	3.7			3	1.1	11	4.0
70–74			14	2.3	10	1.6			1	0.4	11	4.0
75–79			3	0.5	13	2.1					3	1.1
80–84			1	0.7	8	1.3					1	0.4
85–89												
90–94											1	0.4
Total	215	35.0	220	36.0	179	29.2	195	70.8	29	10.6	52	18.8
North of Poughkeepsie												
10–14												
15–19	2	2.9					1	1.4				
20–24	18	26.5					27	9.3				
25–29	5	7.4					82	28.2				
30–34	1	1.5					87	29.9				
35–39							41	14.1				
40–44							18	6.2				
45–49							3	1.0				
50–54			7	10.3	3	4.4			1	0.3		
55–59			7	10.3	3	4.4			3	1.0		
60–64			6	8.8	5	7.4			5	1.7	2	0.7
65–69			3	4.4	4	5.9			1	0.3	6	2.1
70–74			1	1.5	3	4.4					5	1.7
75–79											5	1.7
80–84												
85–89											1	0.3
90–94												
Total	26	38.3	24	35.3	18	26.5	262	90.1	10	3.3	19	6.5

* Percentages based on total specimens for period.

distribution for the mature fish, those I+ and older, showed the females to have been larger than the males.

The saltwater killifish, unlike the related freshwater species, was found mostly below Poughkeepsie during Period 1. The 0+ fish had a modal length of 20–24 millimeters during Period 1 and 25–29 millimeters during Period 2 (Table 5 and Figure 5). Also, as in the freshwater killifish, the adult females were larger than the males.

The northern silverside was caught only below Poughkeepsie, and those taken were exclusively 0+ fish (Table 5 and Figure 5). The modal length was 55–59 millimeters in Period 1 and 65–69 millimeters in Period 2.

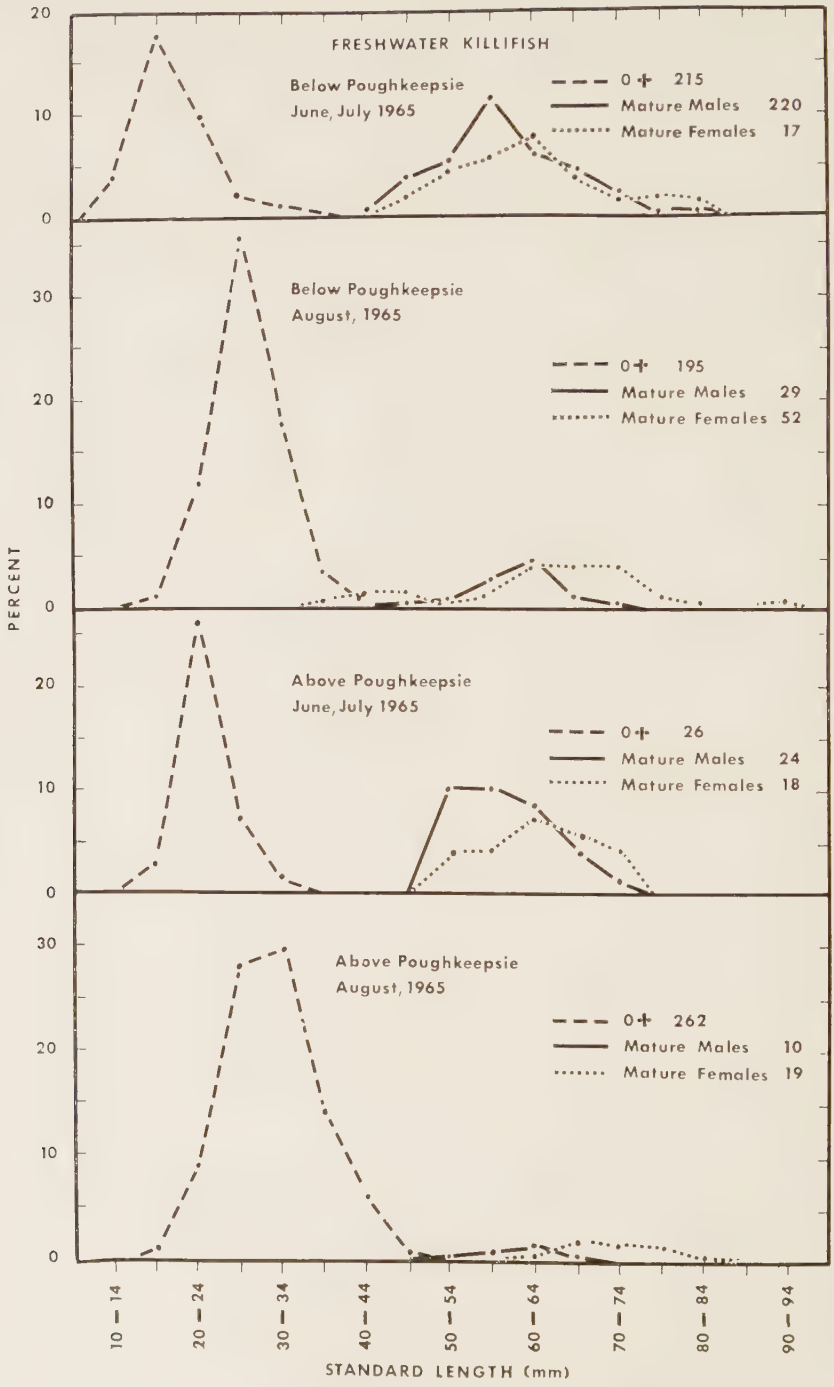


Figure 4. Length-frequency distribution for freshwater killifish.

Young-of-the-year goldfish were taken both above and below Poughkeepsie (Table 5 and Figure 5). Fish caught in the northern

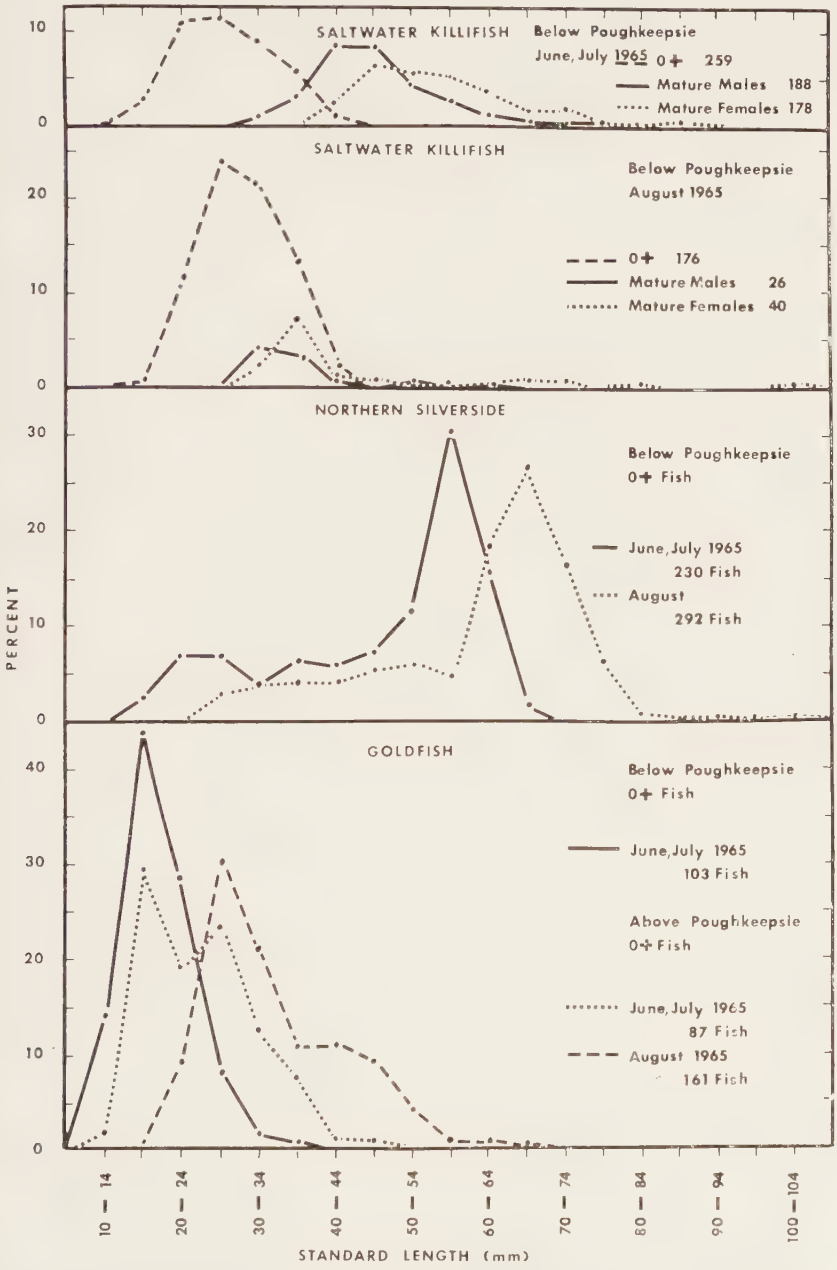


Figure 5. Length-frequency distribution for saltwater killifish, northern silverside and goldfish.

TABLE 5. LENGTH-FREQUENCY DISTRIBUTION RECORDED FOR SALTWATER KILLIFISH, COMMON SILVERSIDE AND GOLDFISH

Standard length (millimeters)	Saltwater killifish												Northern Silverside				Goldfish					
	South of Poughkeepsie												South of Poughkeepsie				South of Poughkeepsie		North of Poughkeepsie			
	Period 1*						Period 2*						Period 1		Period 2		Period 1		Period 1		Period 2	
	Immature		Mature				Immature		Mature													
			Male		Female				Male		Female											
	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent
10–14	1	0.2	..	..	..	..	..	..	..	..	..	..	..	..	..	..	15	14.3	2	2.3	..	..
15–19	17	2.7	..	..	..	..	2	0.8	..	..	..	..	6	2.6	..	..	46	43.8	26	29.5	..	..
20–24	69	11.0	..	..	..	..	28	11.6	..	..	..	..	16	7.0	..	..	30	28.6	17	19.3	15	9.3
25–29	73	11.7	..	..	..	..	58	24.0	..	..	..	..	16	7.0	8	2.7	9	8.6	21	23.9	49	30.4
30–34	56	9.0	6	1.0	..	..	53	21.9	11	4.5	6	2.5	8	3.5	11	3.8	2	1.9	11	12.5	34	21.1
35–39	36	5.8	19	3.0	..	..	32	13.2	9	3.7	18	7.4	15	6.5	12	4.1	1	1.0	7	8.0	18	11.2
40–44	7	1.1	54	8.6	16	2.6	3	1.2	2	0.8	6	2.5	14	6.1	12	4.1	..	..	1	1.1	18	11.2
45–49	..	..	53	8.5	40	6.4	..	..	..	..	2	0.8	17	7.4	16	5.5	..	..	1	1.1	15	9.3
50–54	..	..	26	4.2	35	5.6	..	..	2	0.8	1	0.4	27	11.7	17	5.8	..	..	..	..	7	4.3
55–59	..	..	16	2.6	33	5.3	..	..	1	0.4	..	..	71	30.9	14	4.8	..	..	..	..	2	1.2
60–64	..	..	9	1.4	24	3.8	..	..	1	0.4	1	0.4	37	16.1	54	18.5	..	..	..	..	2	1.2
65–69	..	..	3	0.5	10	1.6	..	..	..	..	2	0.8	3	1.3	78	26.7	..	..	..	..	1	0.6
70–74	..	..	2	0.3	11	1.8	..	..	..	..	2	0.8	..	..	48	16.4	..	..	..	..	..	..
75–79	..	..	..	..	2	0.3	..	..	..	..	..	..	..	..	18	6.2	..	..	..	..	..	..
70–84	..	..	..	..	1	0.2	..	..	..	..	1	0.4	..	..	2	0.7	..	..	..	..	..	..
85–89	..	..	..	..	3	0.5	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
90–94	..	..	..	..	3	0.5	..	..	..	..	..	..	..	..	1	0.3	..	..	..	..	..	..
95–99	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
100–104	..	..	..	..	..	..	..	..	..	..	1	0.4	..	..	1	0.3	..	..	1	1.1	..	..
150–154	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	1.0	..	..	..	..
200–204	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	1.0	..	..	..	..
205–209	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	1.1	..	..
Total	259	41.5	188	30.1	178	28.6	176	72.7	26	10.6	40	16.4	230	100.1	292	99.9	105	100.2	88	99.9	161	99.8

* Percentages based on total specimens for period.

area appeared to be larger in size with modal lengths during Period 1 of 15–19 millimeters and 25–29 millimeters compared with a modal length of 15–19 millimeters in the southern area. In Period 2, the modal length of fish above Poughkeepsie was 25–29 millimeters. No data were available on fish in the southern area during this period.

For another cyprinid, the spottail shiner, 0+ fish were larger in the northern area than in the southern area during Period 1 (Table 6 and Figure 6). In both areas fish of this age group ranged from 10 to 39 millimeters, but in the northern area the modal length was 30–34 millimeters while in the southern area it was 20–24 millimeters. In Period 2, there was no difference in mode between fish from the two areas.

The common sunfish was not available in large enough numbers to compare the size distributions in the two areas (Table 6 and Figure 6). However, considering the river as a whole, the 0+ fish ranged in Period 1 from 10 to 24 millimeters with a mode at 15–19 millimeters and in Period 2 from 10 to 44 millimeters with modes at 15–19 millimeters and 25–29 millimeters.

The Johnny darter occurred in both areas throughout the investigation, and the catch consisted mostly of 0+ fish. In this age group, lengths varied from 10 to 39 millimeters in Period 1. As with other species already cited the fish appeared larger in the northern area than in the southern area with modal lengths of 30–34 millimeters and 25–29 millimeters, respectively (Table 6 and Figure 6). This difference in length was not present in Period 2.

Relatively few carp, golden shiners and tidewater silversides were caught throughout the river (Table 7). The young-of-the-year carp ranged in size from 10 to 49 millimeters, while golden shiners ranged from 25 to 89 millimeters. The tidewater silversides, taken only below Poughkeepsie, were all 0+ fish and ranged in size from 25 to 64 millimeters.

Bay anchovy and white mullet were caught only at the lower stations of the southern area and were all 0+ fish (Table 7). The anchovy varied from 20 to 34 millimeters in length, while the mullet ranged from 25 to 84 millimeters.

The final species to be considered, the American eel, ranged in size from 60 to 454 millimeters (Table 2). The size distribution by year class could not be determined as no data on age were available.

Aside from usefulness in delineating the 0+ age group for the various species, the length frequencies indicated that many of the species were larger in size during Period 1 in the area above Poughkeepsie than in the southern area. Whether this was due to earlier spawning or more favorable environmental conditions in the freshwater reaches of the river is not known.

Table 6. Length-frequency Distribution Recorded for Spottail Shiner, Common Sunfish and Johnny Darter

Standard length (millimeters)	Spottail shiner								Common sunfish				Johnny darter							
	South of Poughkeepsie				North of Poughkeepsie				All Stations				South of Poughkeepsie				North of Poughkeepsie			
	Period 1		Period 2		Period 1		Period 2		Period 1		Period 2		Period 1		Period 2		Period 1		Period 2	
	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent
10–14	8	3.7	..	..	17	9.1	..	..	9	5.7	1	0.5	4	2.6	..	..	2	1.4	..	..
15–19	31	14.3	..	..	9	4.8	..	..	29	18.4	53	28.5	33	21.2	..	..	3	2.1	..	..
20–24	65	30.1	..	..	33	17.6	1	0.5	19	12.0	41	22.0	31	19.9	..	..	6	4.1	4	1.6
25–29	49	22.7	8	6.7	41	21.9	10	5.4	..	..	42	22.6	64	41.0	..	..	53	36.3	10	4.0
30–34	24	11.1	29	24.4	45	24.1	31	16.7	..	..	16	8.6	16	10.3	3	30.0	54	37.0	46	18.3
35–39	5	2.3	49	41.2	9	4.8	98	52.7	..	..	13	7.0	1	0.6	2	20.0	5	3.4	103	40.9
40–44	..	..	23	19.3	..	..	40	21.5	..	..	1	0.5	..	..	2	20.0	..	..	75	29.8
45–49	2	0.9	4	3.4	..	..	3	1.6	..	..	..	..	2	1.3	3	30.0	2	1.4	12	4.8
50–54	4	1.9	..	..	..	..	1	0.5	3	1.9	..	..	5	3.2	..	..	6	4.1	..	..
55–59	10	4.6	..	..	..	..	..	..	4	2.5	1	0.5	..	..	..	..	10	6.8	1	0.4
60–64	8	3.7	..	..	1	0.5	..	..	6	3.8	..	..	..	..	..	..	4	2.7	..	..
65–69	6	2.8	3	2.5	7	3.7	..	..	6	3.8	1	0.5	..	..	..	..	1	0.7	1	0.4
70–74	2	0.9	..	..	17	9.1	1	0.5	5	3.2	..	..	..	..	..	..	..	..	..	..
75–79	1	0.5	1	0.8	6	3.2	1	0.5	4	2.5	4	2.2	..	..	..	..	..	..	..	..
80–84	..	..	2	1.7	1	0.5	..	..	2	1.3	4	2.2	..	..	..	..	..	..	..	..
85–89	1	0.5	..	..	1	0.5	..	..	2	1.3	2	1.1	..	..	..	..	..	..	..	..
90–94	..	..	..	..	..	..	..	..	5	3.2	2	1.1	..	..	..	..	..	..	..	..
95–99	..	..	..	..	..	..	..	..	6	3.8	1	0.5	..	..	..	..	..	..	..	..
100–104	..	..	..	..	..	..	..	..	13	8.2	1	0.5	..	..	..	..	..	..	..	..
105–109	..	..	..	..	..	..	..	..	14	8.9	..	..	..	..	..	..	..	..	..	..
110–114	..	..	..	..	..	..	..	..	15	9.5	..	..	..	..	..	..	..	..	..	..
115–119	..	..	..	..	..	..	..	..	6	3.8	3	1.6	..	..	..	..	..	..	..	..
120–124	..	..	..	..	..	..	..	..	1	0.6	..	..	..	..	..	..	..	..	..	..
125–129	..	..	..	..	..	..	..	..	2	1.3	..	..	..	..	..	..	..	..	..	..
130–134	..	..	..	..	..	..	..	..	4	2.5	..	..	..	..	..	..	..	..	..	..
135–139	..	..	..	..	..	..	..	..	2	1.3	..	..	..	..	..	..	..	..	..	..
140–144	..	..	..	..	..	..	..	..	1	0.6	..	..	..	..	..	..	..	..	..	..
Total	216	100.0	119	100.0	187	99.8	186	99.9	158	100.1	186	99.9	156	100.1	10	100.0	146	100.0	252	100.2

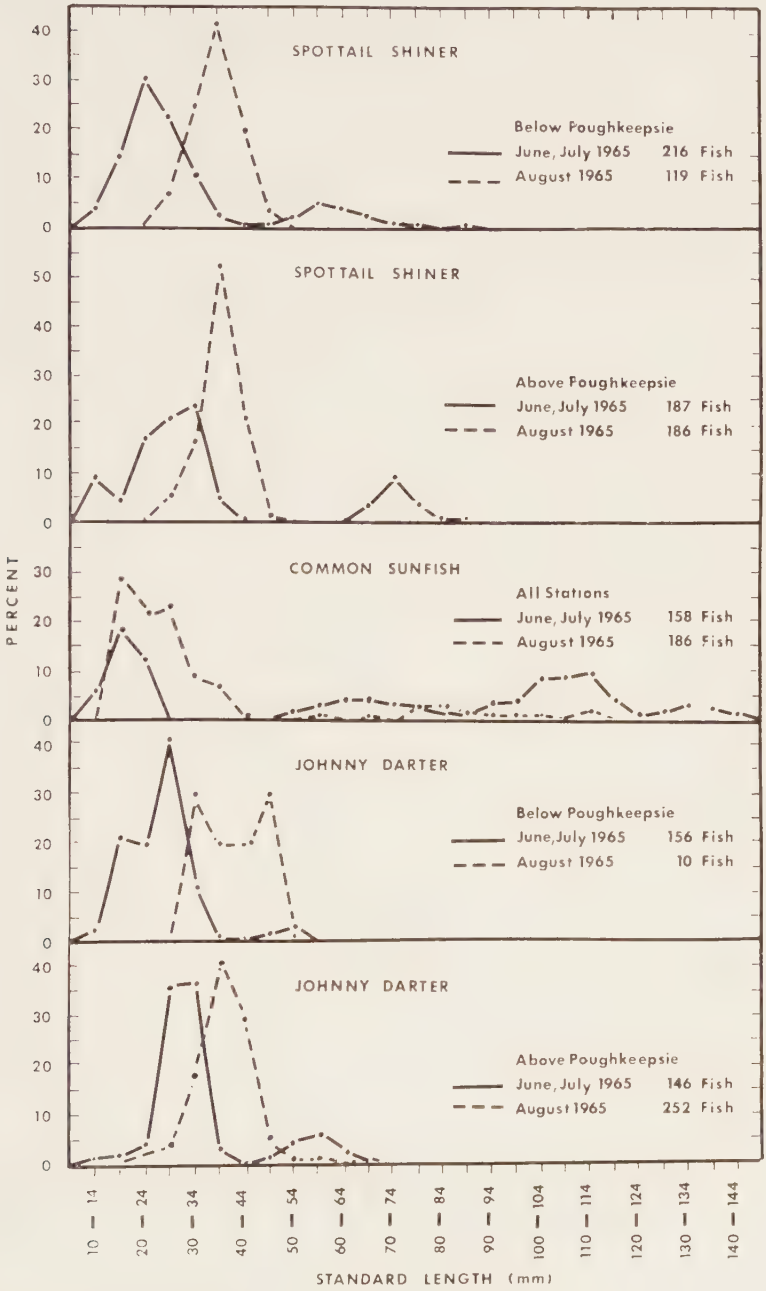


Figure 6. Length-frequency distribution for spottail shiner, common sunfish and Johnny darter.

Table 7. Length-frequency Distribution Recorded for Carp, Golden Shiner, Tidewater Silverside, Bay Anchovy and White Mullet

Standard length (millimeters)	Carp		Golden shiner		Tidewater silverside		Bay anchovy		White mullet	
	All stations (both periods)		All stations (both periods)		South of Poughkeepsie Period 2		South of Poughkeepsie Period 2		South of Poughkeepsie Period 2	
	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent
10–14	1	8.3	..	..	..	..	..	..	..	..
15–19	1	8.3	..	..	..	..	..	..	..	..
20–24	..	..	..	..	..	..	54	54.0	..	..
25–29	1	8.3	1	5.3	1	5.6	44	44.0	9	9.8
30–34	2	16.7	2	10.5	..	..	2	2.0	15	16.3
35–39	2	16.7	2	10.5	..	..	..	..	19	20.7
40–44	4	33.3	..	..	..	..	..	..	9	9.8
45–49	1	8.3	1	5.3	..	..	..	..	1	1.1
50–54	..	..	..	..	3	16.7	..	..	5	5.4
55–59	..	..	1	5.3	12	66.7	..	..	14	15.2
60–64	..	..	..	..	2	11.1	..	..	12	13.0
65–69	..	..	1	5.3	..	..	..	..	5	5.4
70–74	..	..	..	..	..	..	..	..	1	1.1
75–79	..	..	2	10.5	..	..	..	..	..	..
80–84	..	..	..	..	..	..	..	..	2	2.2
85–89	..	..	2	10.5	..	..	..	..	..	..
90–94	..	..	..	..	..	..	..	..	..	..
95–99	..	..	..	..	..	..	..	..	..	..
100–104	..	..	1	5.3	..	..	..	..	..	..
105–109	..	..	1	5.3	..	..	..	..	..	..
110–114	..	..	1	5.3	..	..	..	..	..	..
130–134	..	..	2	10.5	..	..	..	..	..	..
145–149	..	..	1	5.3	..	..	..	..	..	..
170–174	..	..	1	5.3	..	..	..	..	..	..
Total	12	99.9	19	100.2	18	100.1	100	100.0	92	100.0

Relative Abundance

On the basis of both the length frequencies presented here and the age-length frequencies computed for 1964 by Eisenbud *et al.* (1965), the comparative catches of 0+ and I+ or older fish were computed for the entire collection period for each species and for all species, both for individual stations and all stations combined (Table 8 and Figure 7). As has been explained, these comparative figures were computed from data for measured areas of seining at the various stations and converted to an arbitrary unit of catch per 100,000 square

TABLE 8. AVERAGE CATCH* AT EACH STATION FOR THE 18 SPECIES TAKEN MOST FREQUENTLY

Age group	Station									Average
	IW3	IIW1	IIW2	IIW2A	IIIW2	IVW1	IVW2	IVW3	IVW4	
Spottail shiner										
0+	0	221	3,124	54	16	40	299	72	149	442
I+ or older	0	32	30	0	59	143	24	0	63	39
Total	0	253	3,154	54	75	183	323	72	212	481
Freshwater killifish										
0+	0	0	225	1,155	129	293	12	311	59	243
I+ or older	4	158	447	227	1,089	76	0	16	25	227
Total	4	158	672	1,382	1,218	369	12	327	84	470
White perch										
0+	23	458	686	27	32	942	71	19	48	256
I+ or older	39	281	313	2	53	55	132	7	166	116
Total	62	739	999	29	85	997	203	26	214	372
Saltwater killifish										
0+	662	178	335	45	46	0	0	6	5	142
I+ or older	257	277	814	45	544	0	0	10	52	222
Total	919	455	1,149	90	590	0	0	16	57	364
Common silverside										
0+	2,341	693	0	0	0	0	0	0	0	337
Johnny darter										
0+	0	15	1,785	10	86	54	13	895	44	323
I+ or older	0	4	0	0	8	15	18	12	56	13
Total	0	19	1,785	10	94	69	31	907	100	336
Blueback herring										
0+	0	42	27	32	45	4	1,071	632	601	273
Shad										
0+	0	126	0	59	168	11	178	9	103	73
Alewife										
0+	0	41	8	5	15	107	115	169	125	65
Bay anchovy										
0+	1,442	0	0	0	0	0	0	0	0	160
White mullet										
0+	292	0	0	0	0	0	0	0	0	32
Tidewater silverside										
0+	160	4	0	0	0	0	0	0	0	18
Goldfish										
0+	0	0	0	248	10	648	2	59	0	107

Table 8. (*continued*)

Age group	Station									Aver-age
	IW3	IIW1	IIW2	IIW2A	IIIW2	IVW1	IVW2	IVW3	IVW4	
Carp										
0+	0	0	0	9	0	8	1	6	0	3
Golden shiner										
0+	0	4	0	11	2	24	0	9	15	7
Common sunfish										
0+	0	0	0	133	4	24	0	316	0	53
I+ or older	0	4	107	165	10	25	4	9	1	36
Total	0	4	107	298	14	49	4	325	1	89
Striped bass										
0+	15	76	200	19	0	5	19	0	0	37
I+ or older	3	12	8	5	0	3	3	0	0	4
Total	18	88	208	24	0	8	22	0	0	41
American eel										
Total	18	36	30	99	6	5	9	11	41	28
Total										
Total	5,256	2,666	8,346	2,300	2,335	2,482	1,971	2,568	1,553	3,281

* Per unit area (see text).

feet of shore area seined. This unit of catch is designated "p.u.a." (per unit area) throughout the remainder of this paper.

The relative abundance for all species taken at each station throughout the period studied ranged from 1,553 to 8,346 p.u.a. However, at seven of the nine stations the range was much smaller, 1,553 to 2,666 p.u.a. High levels of abundance prevailed at Stations I W 3 and II W 2 with figures of 5,256 and 8,346 p.u.a., respectively. The high level at Station I W 3 was influenced by penetration of such species as the northern silverside, bay anchovy and white mullet from the relatively salt water of the southern reaches of the Hudson River. At Station II W 2, the backwater environment appeared to be a favorable nursery habitat, particularly for the spottail shiner, salt-water killifish, white perch and Johnny darter. For each species, its relative abundance at each station, in terms of departure from the average, is shown in Figure 8, 9 and 10. The stations at which each species was most abundant are given in Table 9.

Of the 18 species considered, the spottail shiner was the most abundant, averaging 481 fish p.u.a. They were taken at all stations except the southernmost (I W 3), and most of the catch were 0+ fish.

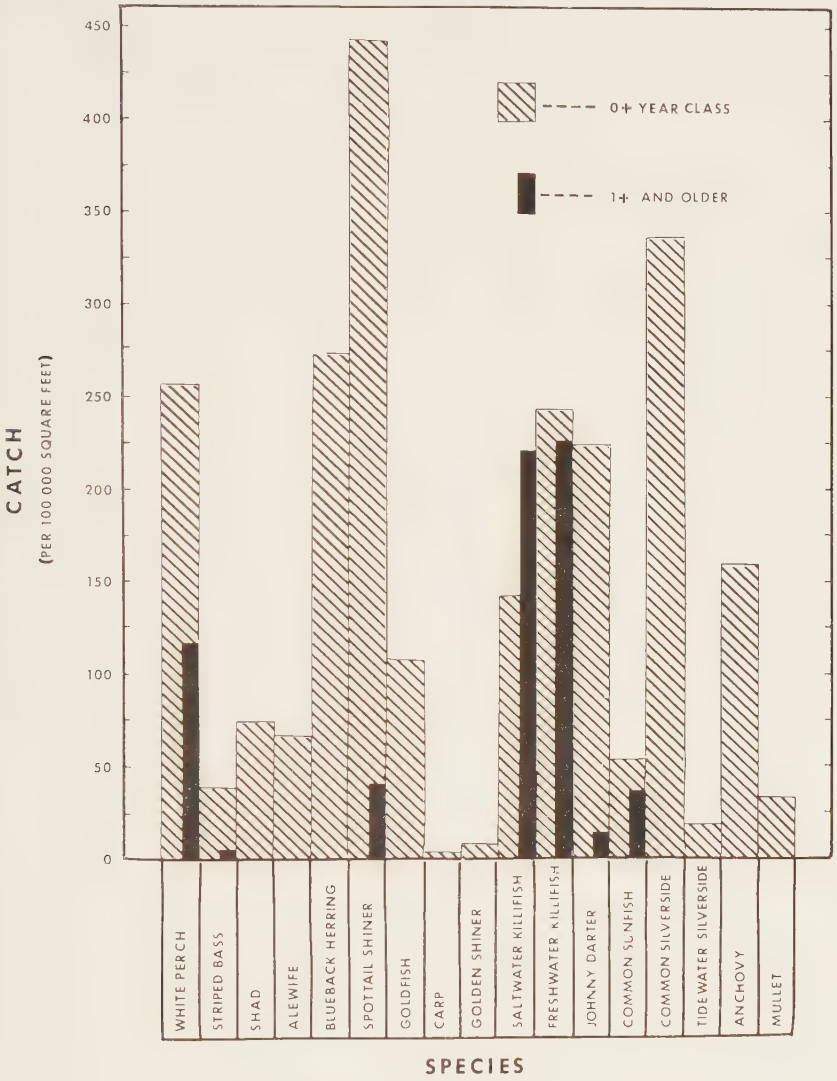


Figure 7. Relative abundance of the 0+ and the 1+ or older age groups of the various species in 1965.

The second most abundant species was the freshwater killifish, some being caught at all stations. Almost half of those taken were 1+ and older fish.

The white perch, saltwater killifish, common silverside and Johnny darter were closely grouped as the next most abundant species. More than two-thirds of the white perch were 0+ fish, but both age groups were represented at all stations. Saltwater killifish were taken very

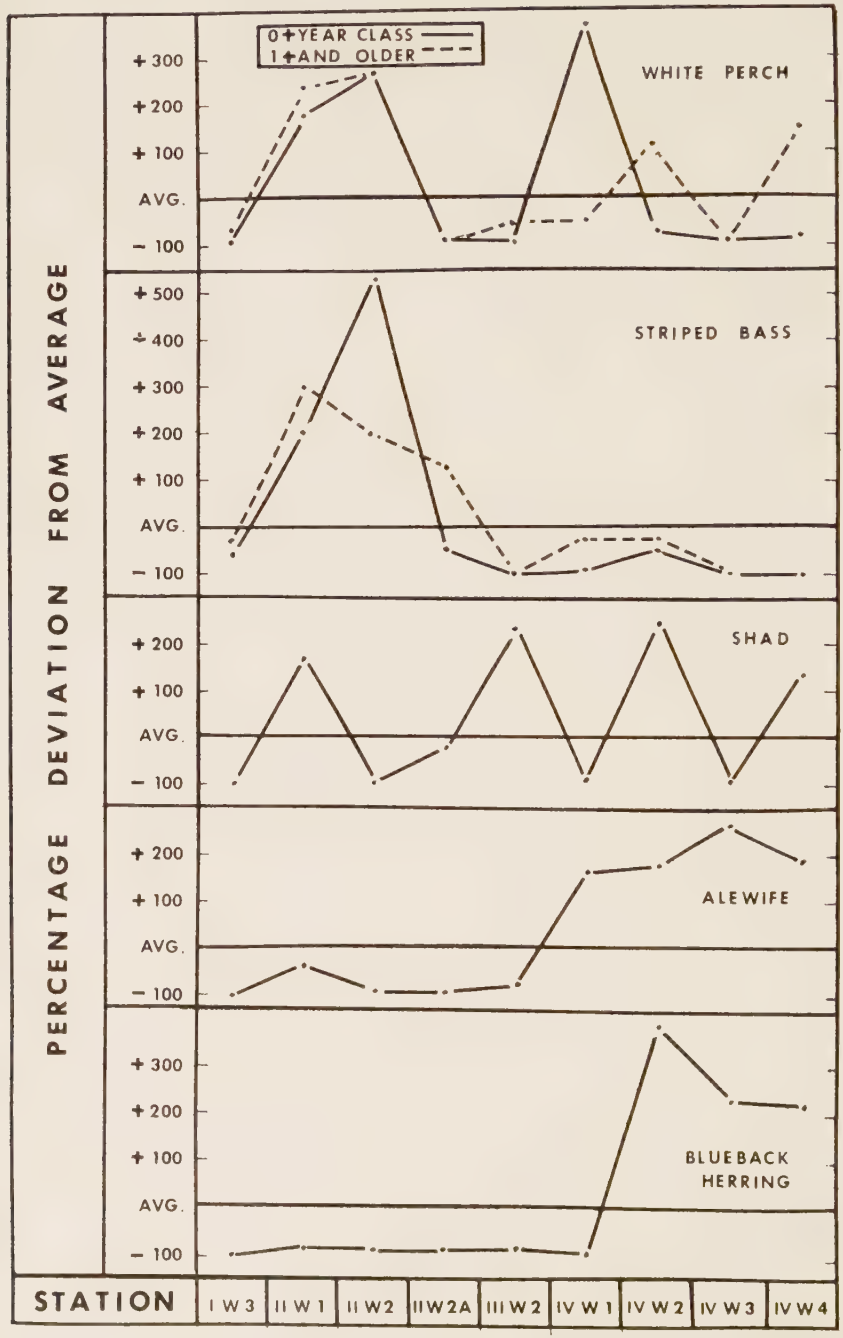


Figure 8. Relative abundance of white perch, striped bass, shad, alewife and blueback herring at the various collecting stations in 1965.

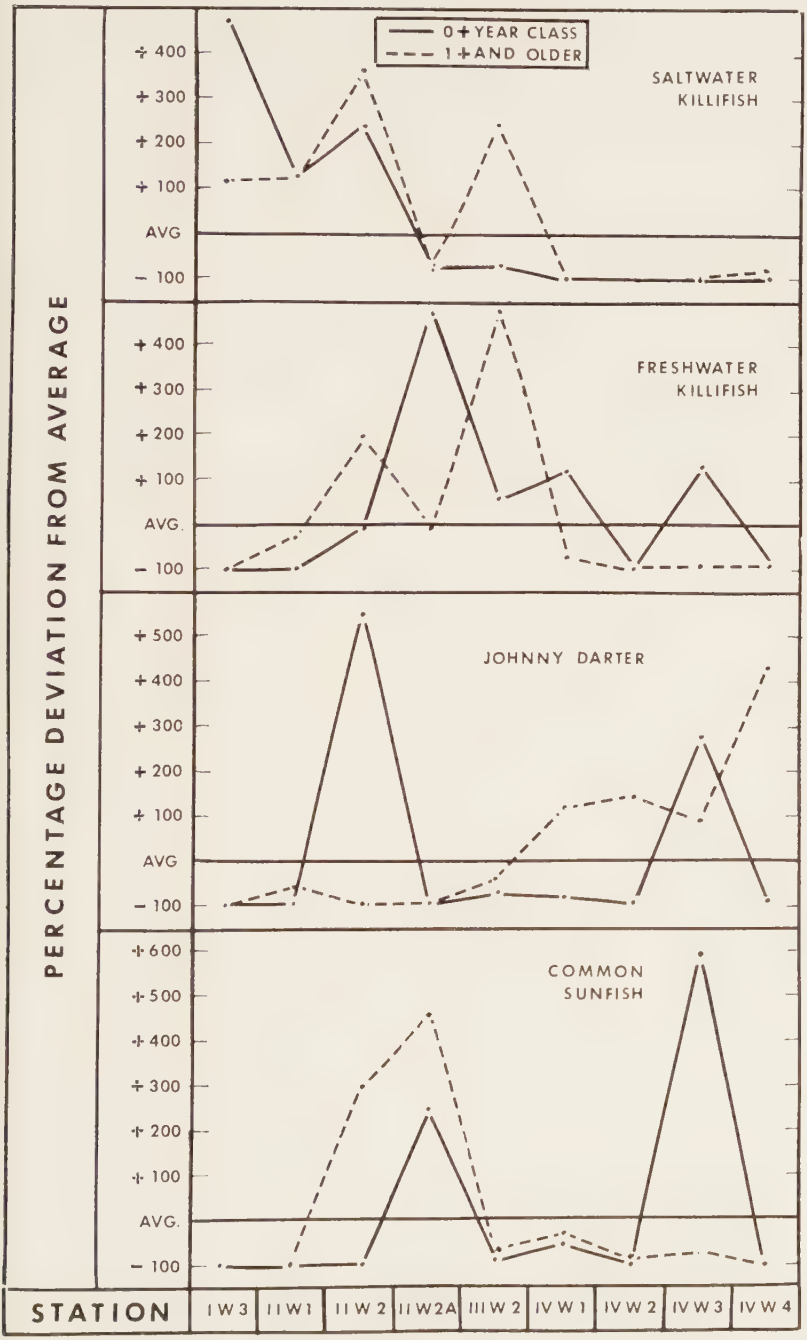


Figure 9. Relative abundance of saltwater killifish, freshwater killifish, Johnny darter and common sunfish at the various collecting stations in 1965.

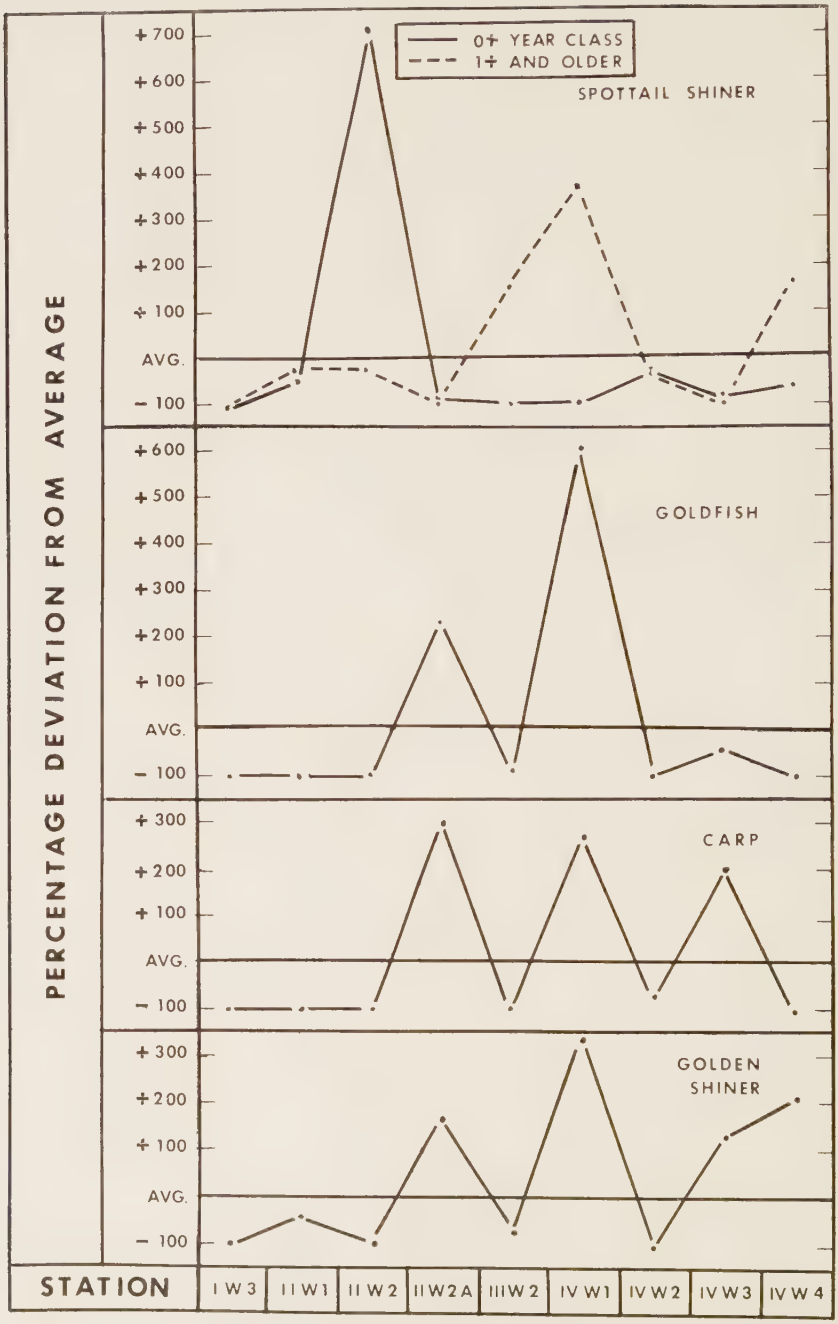


Figure 10. Relative abundance of spottail shiner, goldfish, carp and golden shiner at the various collecting stations in 1965.

TABLE 9. STATIONS AT WHICH THE PRINCIPAL SPECIES WERE MOST ABUNDANT

Species and age group	I W 3	II W 1	II W 2	I–II W 2A	III W 2	IV W 1	IV W 2	IV W 3	IV W 4	Remarks
Spottail shiner										
0+			*							
I+ or older					*	*			*	
Freshwater killifish										
0+			*	*	*	*		*		
I+ or older		*	*	*	*					
White perch										
0+		*	*			*				
I+ or older		*	*				*		*	
Saltwater killifish										
0+	*	*	*							
I+ or older	*	*	*		*					
Northern silverside	*	*								all 0+
Johnny darter										
0+			*					*		
I+ or older						*	*	*	*	
Blueback herring							*	*	*	all 0+
Shad		*		*	*		*		*	all 0+
Alewife						*	*	*	*	all 0+
Bay anchovy	*									all 0+
White mullet	*									all 0+
Tidewater silverside	*									all 0+
Goldfish				*		*		*		all 0+
Carp				*		*		*		all 0+
Golden shiner				*		*			*	all 0+
Common sunfish										
0+				*				*		
I+ or older			*	*						
Striped bass										
0+		*	*							
I+ or older		*	*	*						
American eel		*	*	*					*	all ages

largely south of Poughkeepsie, and more than 60 per cent were I+ or older fish. The catch of northern silversides comprised only 0+ fish and was limited exclusively to the southernmost two stations in the euryhaline zone (I W 3 and II W 1). Johnny darters were

taken at all stations except I W 3 and were preponderantly 0+ fish, but most of the relatively few I+ or older specimens were taken above Poughkeepsie.

The blueback herring was next in order of abundance and occurred chiefly north of Poughkeepsie. The two other clupeids commonly found in the Hudson River, the shad and alewife, were approximately one-fourth as numerous as the blueback herring. Although shad were plentiful at stations both above and below Poughkeepsie, most of the alewives encountered were in the southern area. For all three species, only 0+ fish were recorded.

The bay anchovy and white mullet were taken only at the southernmost station, and the tidewater silverside was limited almost entirely to that station. All were 0+ fish. Relatively few of the latter two species were caught.

Moderate numbers of goldfish were taken. The relative distribution of this species and of carp and golden shiners was similar although the latter were scarce. These, too, were 0+ fish.

The common sunfish was well distributed, although it was absent at the southernmost station. About 60 per cent of those taken were 0+ fish.

Striped bass were not numerous; 41 p.u.a. were recorded for all ages, about 90 per cent of which were 0+ fish. This species was encountered chiefly from Station II W 2A at Cornwall southward.

A few American eels were taken at all stations.

DISCUSSION

The information presented here is basic to an understanding of the effects of changes in environmental conditions in the Hudson River on its fish populations. The levels of abundance of the species collected along the shores of the lower part of the river in 1965, particularly for the 0+ age group, should serve as standards for comparison in subsequent years. Further studies are now in progress to examine the relationships of major, man-induced environmental changes to fluctuations in the abundance of fish.

LITERATURE CITED

Anderson, A. S., and E. A. Power. 1946–1957. Fishery statistics of the United States. Statistical Digest Nos. 11, 14, 16, 18, 19, 21, 22, 25, 27, 30, 34, 36, 39 and 41 [for years 1942 to 1955] U. S. Department of Interior.

Eisenbud, M., A. Perlmutter, A. W. McCrone and H. I. Hirschfield. 1965. Radioecological Survey of the Hudson River, Progress Report No. 1. Div. Radiolog. Health, Bureau of State Serv., U. S. Public Health Serv. (Contract PH 86-64-Neg. 141)

Fiedler, R. H. 1932–1941. Fishery Industries (Statistics of the United States [for years 1930 to 1938]). Appendices to Report of Commissioner of Fisheries, U. S. Department of Interior.

———————— 1942–1945. Fishery statistics of the United States. Statistical Digest Nos. 1, 4 and 7. [for years 1939 to 1941] U. S. Department of Interior.

New York State Conservation Department. 1933. A biological survey of the Upper Hudson Watershed. N.Y.S. Cons. Dept., Albany, N. Y.

———————— 1935. A biological survey of the Mohawk-Hudson Watershed. N.Y.S. Cons. Dept., Albany, N. Y.

———————— 1937. A biological survey of the Lower Hudson River Watershed. N.Y.S. Cons. Dept., Albany, N. Y.

Power, E. A. 1958–1963. Fishery Statistics of the United States. Statistical Digest Nos. 43, 44, 49, 51, 53 and 54. [for years 1956 to 1961] U. S. Department of Interior.

Rathjen, W. F., and L. C. Miller. 1957. Aspects of the early life history of the striped bass (*Roccus saxatilis*) in the Hudson River. N. Y. Fish and Game Jour. 4 (1) :43–60.

Talbot, Gerald B. 1954. Factors associated with fluctuations in abundance of Hudson River shad. U. S. Dept. Int., Fish and Wildl. Serv., Fish. Bull. 56 (101) :373–413.

GENERAL NOTES

MINERAL CONTENT OF DEER BROWSE ON THE HUNTINGTON WILDLIFE FOREST[1]

James A. Bailey Instructor
State University College of Forestry[2]

The soils of the Adirondack region of New York are listed as strongly acid and low in all major nutrients by Cline (1955). Analyses of soil samples collected on the Huntington Wildlife Forest near Newcomb in the central part of the region substantiate this statement. Soil pH values of less than 4.0 were common in samples from the top 6 inches. Truog (1946) indicated that phosphorous is largely unavailable to plants in acid soils, and the surface soils on the Huntington Forest often contained less than 7 pounds of available phosphorus per acre[3]. Plantings of grasses and legumes on this area have always responded markedly to fertilization with phosphorus[4], indicating a deficiency of this element in the soil.

These facts aroused interest in the adequacy of the mineral nutrition of white-tailed deer *(Odocoileus virginianus)* on the Huntington Forest, especially the adequacy of dietary phosphorus during winter when food availability is low. Accordingly, samples of deer browse were collected and analyzed for calcium and phosphorus. Information on potassium, magnesium and sodium was also obtained and is reported here without discussion.

Samples of 20 species of deer browse were collected from several habitat types in five locations on the Huntington Forest during February and early March in 1963. Two locations were within areas frequented by wintering deer. The three others were selected in order to obtain additional species. The tips of dominant twigs between 2 and 7 feet above the ground were removed from 10 or more plants of each species sampled at each collection site. Each tip was cut 1 inch behind the base of its terminal bud. Tips were pooled by species and location. They were dried on the day of collection at 65° C., after which they were ground in a Wiley mill and analyzed for minerals in the soils laboratory of the College of Forestry. Ash content was determined gravimetrically; phosphorus, colorimetrically with vanadate yellow; and the remaining minerals, with flame emission spectrophotometry (after phosphorus removal). These methods were described by Wilde *et al.* (1964).

The analyses for the various browse species are presented in Table 1. Most samples were low in phosphorus. Calcium-phosphorus ratios varied from 2.8 to 12.5.

Dietz (1965) noted with respect to deer that "A deficiency of phosphorus or a wide calcium-phosphorus ratio could cause retarded growth, a high feed requirement, unthrifty appearance, weak young, decreased lactation, failure to conceive, stiffness of joints, and many other abnormalities." He also noted that the National Research Council of the National Academy of Sciences has established 0.16 per cent as the minimum phosphorus requirement of pregnant ewes. Maynard and Loosli (1956) observed that calcium and phosphorus assimilation is inefficient when the ratio of one element to the other in the forage is large. They described the desirable calcium-phosphorus ratio as one between 0.5 and 2.0 but noted that the ratio becomes less critical with plenty of vitamin D in the diet.

Eleven of the 20 species of browse from the Huntington Forest had phosphorus concentrations of less than 0.16 per cent. Only wild raisin and elderberry had levels above 0.2 per cent. Except for red spruce which is seldom eaten by deer, only balsam fir, hemlock and elderberry had calcium-phosphorus ratios of less than 3.0. Most species of browse which are heavily used by wintering deer had ratios of more than 5.0.

These data suggest a phosphorus deficiency in deer browse on the Huntington Forest. However, it has not been shown that lower mortality or greater reproductive success would result from improving the phosphorus nutrition of these deer. Addi-

---

[1] The auhor wishes to acknowledge the help of Dr. Albert Leaf of the State University College of Forestry who directed chemical analyses of browse samples and to thank the staff of the Huntington Wildlife Forest for their cooperation.

[2] Present affiliation: Illinois Natural History Survey, Urbana, Illinois.

[3] Dr. Albert Leaf, New York State Universiy College of Forestry, personal communication.

[4] Dr. Earl Patric, Huntington Wildlife Forest, personal communication.

Table 1. Mineral Content of Samples of Deer Browse Collected on the Huntington Wildlife Forest during February and Early in March in 1963

Species	Number of locations sampled	Mineral content in percentage of dry weight (average for all locations sampled)						Calcium-phosphorus ratio
		Ash	Calcium	Phosphorus	Potassium	Magnesium	Sodium	
Balsam fir (*Abies balsamea*)	3	2.8	0.44	0.16	0.57	0.10	0.04	2.8
White cedar (*Thuja occidentalis*)	3	4.2	0.82	0.14	0.38	0.12	0.06	5.9
Red spruce (*Picea rubens*)	1	3.6	0.50	0.18	1.13	0.17	0.09	2.8
White pine (*Pinus strobus*)	2	2.2	0.59	0.12	0.62	0.09	0.07	4.9
Hemlock (*Tsuga canadensis*)	2	2.8	0.48	0.17	0.56	0.11	0.03	2.8
Sugar maple (*Acer saccharum*)	2	5.2	1.24	0.14	0.64	0.13	0.07	8.9
Striped maple (*Acer pennsylvanicum*)	3	4.1	0.95	0.17	0.58	0.22	0.06	5.6
Red maple (*Acer rubrum*)	1	5.8	1.52	0.16	0.39	0.12	0.07	9.5
Speckled alder (*Alnus incana*)	2	3.1	0.58	0.15	0.31	0.14	0.04	3.9
Yellow birch (*Betula lutea*)	1	3.3	0.82	0.14	0.32	0.15	0.05	5.9
Alternate-leaved dogwood (*Cornus alternifolia*)	1	4.5	1.12	0.10	0.30	0.10	0.05	11.2
Hazelnut (*Corylus rostrata*)	1	5.5	1.55	0.14	0.67	0.15	0.03	11.1
Beech (*Fagus grandifolia*)	2	2.9	0.56	0.15	0.49	0.15	0.04	3.7
White ash (*Fraxinus americana*)	2	3.7	0.84	0.10	0.53	0.09	0.04	8.4
Mountain fly honeysuckle (*Lonicera canadensis*)	1	8.1	1.10	0.17	1.16	0.08	0.12	6.5
Fire cherry (*Prunus pennsylvanica*)	1	4.4	1.88	0.15	0.43	0.10	0.02	12.5
Black cherry (*Prunus serotina*)	1	4.1	1.18	0.17	0.32	0.13	0.05	6.9
Elderberry (*Sambucus* sp.)	1	5.2	0.89	0.32	1.23	0.26	0.07	2.8
Witchhobble (*Viburnum alnifolium*)	2	3.9	0.69	0.17	0.70	0.26	0.04	4.1
Wild raisin (*Viburnum cassinoides*)	2	4.1	1.51	0.22	0.62	0.20	0.07	6.9

tional research, perhaps with penned deer on a phosphorus-supplemented browse diet, would be required to determine this.

LITERATURE CITED

Cline, M. G. 1955. Soils and soil associations of New York. Cornell Univ. Ext. Bull. 930.

Dietz, D. R. 1965. Deer nutrition research in range management. Trans. N. Am. Wildl. Conf. 30:274–284.

Maynard, L. A., and J. K. Loosli. 1956. Animal Nutrition. McGraw-Hill Book Co., New York.

Truog, E. 1946. Soil reaction influence on the availability of plant nutrients. Soil Sci. Soc. Amer. Proc. 11:305–308.

Wilde, S. A., G. K. Voigt and J. G. Iyar. 1964. Soil and Plant Analysis for Tree Culture. Oxford Publ. House, Calcutta, India.

AN UNUSUALLY DENSE POPULATION OF THE CREEK CHUBSUCKER[1]

Dean E. Arnold Research Associate
Department of Conservation, Cornell University[2]

The creek chubsucker *(Erimyzon oblongus oblongus)* is fairly common in the eastern and central United States. It is found both in slow streams and in shallow ponds and lakes. Wagner and Cooper (1963) stated that it is a valuable forage species because it grows quickly to sizes large enough to escape predation, thus assuring an adequate breeding population to produce abundant young. Among the few existing studies of chubsucker populations, those of Underhill (1910), Carnes (1958) and Wagner and Cooper (1963) reported densities of 9, 12, and 8 adults per acre, respectively. These three studies also suggest that the chubsucker occasionally produces unusually strong year classes.

A considerably more dense population, possibly due to one or more strong year classes, existed in Dryden Lake (N. Y.) in 1965–66. This is a weedy, 117-acre lake with a maximum depth of 13.5 feet and a mean depth of 3.5 feet. Fish present in addition to the chubsucker were largemouth bass *(Micropterus salmoides)*, chain pickerel *(Esox niger)*, redfin pickerel *(Esox americanus americanus)*, yellow perch *(Perca flavescens)*, pumpkinseed *(Lepomis gibbosus)*, black crappie *(Pomoxis nigromaculatus)*, white sucker *(Catostomus commersoni)*, brown bullhead *(Ictalurus nebulosus)* and golden shiner *(Notemigonus crysoleucas)*. Further information on the lake and its fish populations is given by Arnold (1966). The chubsucker population appeared similar to those described in the earlier studies except for its density.

Estimates of the adult (6 inches or more in total length) chubsucker population were made in the spring and fall in 1965 using the formula

$$\hat{N} = \frac{M\,(C+1)}{R+1}$$

defined by Ricker (1958, p. 84). The 95 per cent confidence limits for N were determined by using a Clopper-Pearson chart as outlined by Ricker (1958, p. 85). Between April 12 and May 12 fish taken in trap nets distributed around the lake were marked by clipping half the right pectoral fin. Then recapture samples were collected between May 18 and June 7 by electrofishing at night with a boom-type shocker as described by Arnold (1966). The same procedure was followed in estimating the fall population. Fish taken in trap nets between September 20 and October 12 were marked by clipping half the left pectoral fin, and recaptures were made by electrofishing at night from October 18 to November 10. The estimate of the fall

Table 1. Estimatees of the population of adult chubsuckers in Dryden Lake in the spring and fall of 1965

Season	Number marked and released	Recoveries		Population estimate	Confidence limits (95 per cent)	Number per acre
		Total	Marked			
Spring	1,460	277	34	11,597	8,619–16,218	99
Fall						
From sample in fall 1965	988	288	87	3,245	2,754– 4,130	28
From sample in spring 1966	..	392	106	3,629	2,919– 4,314	31

[1] A contribution of Federal Aid in Fish and Wildlife Restoration Project F-17-R.
[2] Present affiliation: Section of Ecology and Systematics, Division of Biological Sciences, Cornell University, Ithaca, N. Y.

Table 2. Number of individuals of each age in samples of chubsuckers from Dryden Lake, 1963–1965

Time of sample	Age						Total sample
	0+	I+	II+	III+	IV+	V+	
Spring 1963	0	0	27*	19	3	0	49
Summer 1964	0	0	0	30*	2	1	33
Spring 1965	0	0	1	11	178*	2	192
Fall 1965	0	4	7	20	82*	5	118

* 1961 year class.

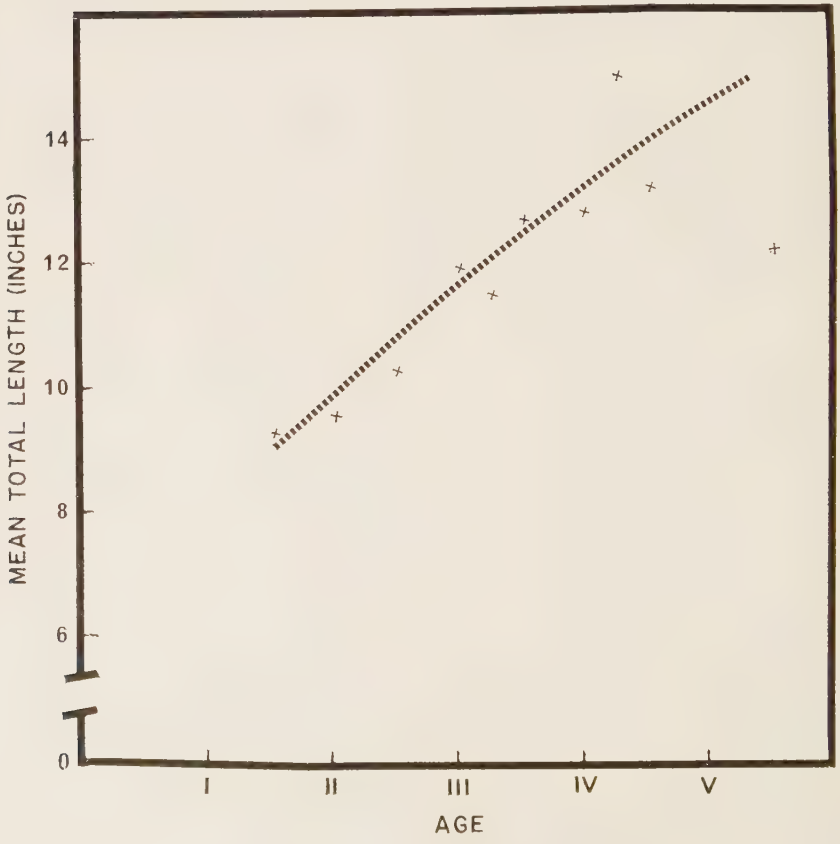


Figure 1. Growth of chubsuckers in Dryden Lake as indicated by mean lengths of age groups in samples for 1963, 1964 and 1965.

population was checked by netting and by electrofishing both at night and during the day from April 14 to May 13 in 1966 when recruitment following the time of marking was negligible due to lack of overwinter growth.

The spring estimate indicated a population density of approximately 99 adults per acre during the spawning season (Table 1). A heavy mortality occurred in the older age groups following spawning, as indicated by the many large chubsuckers found dead near the shoreline or observed being swept over the dam. Nevertheless, the estimates of fall density indicated a remaining population of approximately 30 adults per acre, three times the average reported for the earlier studies. Preliminary estimates indicated that this population made up approximately 20 per cent of the total biomass of adult fish in the lake. The average weight of adult chubsuckers handled during this study was 1.2 pounds.

Table 2 shows that the 1961 year class dominated the samples taken in spring 1963, summer 1964, spring 1965 and fall 1965. Underhill (1940) and Wagner and Cooper (1963) experienced difficulty in sampling chubsuckers of ages 0+ and I+ although their rapid growth should have made them vulnerable to the sampling gear used. This difficulty was also experienced at Dryden Lake (Figure 1 and Table 2), and therefore it is not certain that the 1961 year class was actually significantly larger than others in the population. In any case, the density of chubsuckers in Dryden Lake was considerably greater than that reported for other waters. Although the chubsucker is considered a desirable forage fish because its rapid growth assures adequate survival of brood stock, in some lakes this characteristic may result in an exceptionally large number of adults which may compete for food with more desirable panfish.

LITERATURE CITED

Arnold, Dean E. 1966. Population, survival, growth, and exploitation of fish populations in Dryden Lake; background information for Dryden Lake studies. New York Fed. Aid Project F-17-R (completion report for Job III-a) N.Y.S. Cons. Dept. (multilith.)

Carnes, William C., Jr. 1958. Contributions to the biology of the eastern creek chubsucker, *Erimyzon oblongus oblongus* (Mitchill). M.S. thesis, North Carolina State College Library.

Ricker, William E. 1958. Handbook of computations for biological statistics of fish populations. Fish. Res. Bd. Canada Bull. 119.

Underhill, A. Heaton. 1940. Estimation of a breeding population of chubsuckers. Trans. N. Am. Wildl. Conf. 5:251–256.

Wagner, Charles C., and Edwin L. Cooper. 1963. Population density, growth, and fecundity of the creek chubsucker, *Erimyzon oblongus*. Copeia 1963 (2) :350–357.

NOTES ON THE CARANGID FISHES OF LONG ISLAND[1]

Irwin M. Alperin Conservation Biologist
New York State Conservation Department[2]

The family Carangidae comprises a variety of marine fish including the pompanos, scads, blue runner and several known as "jacks". Of the 25 species reported from the Atlantic coast of the United States (American Fisheries Society, 1960), at least 17 are known to occur in the waters about Long Island. But few make any substantial contribution to New York's commercial or sport fisheries. Those that are taken by commercial fishermen are usually included under miscellaneous species in catch statistics. They have little market value, and most are discarded. Even though many are eaten, and in considerable quantities in many areas of the world, only the pompano *(Trachinotus carolinus)* is favored as a food fish in New York markets. On the other hand, some are esteemed as game fish.

Table 1 lists the species found in Long Island waters and gives the approximate sizes that may be expected (and a few published maxima) together with their general importance to the sport fishery. Only three or four contribute appreciably to the sport catch. Yet on occasion anglers do catch numbers of these fish; usually they cannot identify them and are uncertain whether their catch is a "trophy" or "trash". This is particularly true of the crevalle jack *(Caranx hippos)*, the blue runner *(Caranx crysos)* and the banded rudderfish *(Seriola zonata)*.

In some years the crevalle jack and blue runner add considerably to the catch of light-tackle bay fishermen, especially those angling for snappers, i.e., juvenile bluefish *(Pomatomus saltatrix)*. The snapper fishery is a large one, widespread throughout the Marine District and of special interest to dock, pier and small-boat anglers. In years when snappers are not numerous, jacks and other small species are often taken by these anglers. The small carangids frequent the same waters as the snappers, and when they reach 6 to 8 inches in length they are acceptable as game fish to the snapper fishermen who almost universally refer to them as "amberjacks" —a name that alludes to the generally pale golden or yellow color that suffuses them at that size. In almost every census catches by snapper anglers have been found to include a few of them. Although statistics are not available, *C. hippos* seems to have been the more common during some years, and *C. crysos* during others. On most occasions, however, the latter has predominated.

Blue runners were particularly common during 1964 when anglers caught them in most of the regularly fished areas about Long Island and they were also taken in pound nets off Fire Island. In September and October the Conservation Department's research trawler encountered this species in considerable numbers in the Peconic bays area at the eastern end of Long Island. A sample of 14, taken between October 2 and 10 in Noyack, Little Peconic and Great Peconic Bays, was retained. Additional specimens were obtained from the sport fishery catch at Captree State Park, Fire Island Inlet and Great South Bay. Data for these are given in Table 2.

The latest specimen, which was captured with a hand net on October 24 off Heckscher State Park on Great South Bay, was reported to have been floundering on the surface and was brought to the laboratory of the Bureau of Marine Fisheries for identification. This fish may have been succumbing to a rapid overnight change of temperature in the shallow bay waters. It is not unusual, in the late fall, for fish of southern faunal origin to be found dead or in a distressed condition after a sudden onset of cool weather. However, the blue runner has occurred in Long Island waters well into November. Nichols and Breder (1926) reported it on November 4. Latham (1964) collected 25 (5 to 9½ inches long) at Orient on November 4, 1939 and took another specimen there as late as November 11 in 1944.

Of the 19 specimens of the blue runner which were examined in 1964, nine (47.3 per cent) were infested with a parasitic copepod *(Lernaeenicus longiventris)*[3] as noted in Table 2. Although the most recent studies of this fish, particularly those including examination of young and juveniles, (Ginsburg, 1952; McKenney *et al.*, 1958; Berry, 1959) did not mention infestation by this parasite, Wilson (1917, 1932) reported it earlier from the blue runner and a number of other species at Woods Hole (Mass.).

---

[1] A contribution of Federal Aid in Fish and Wildlife Restoration Project F-15-R.
[2] Present affiliation: Massachusetts Division of Marine Fisheries, Boston, Mass.
[3] Identification confirmed by T. E. Bowman, U. S. National Museum.

. The banded rudderfish is not seen as regularly as either species of *Caranx*, and. ile specimens are usually larger, it is more difficult to attract by stillfishing. ·cimens weighing from three-quarters of a pound to a pound or more are not

BLE 1. The Carangids of Long Island, Their Size Range and Importance to the Sport Fishery

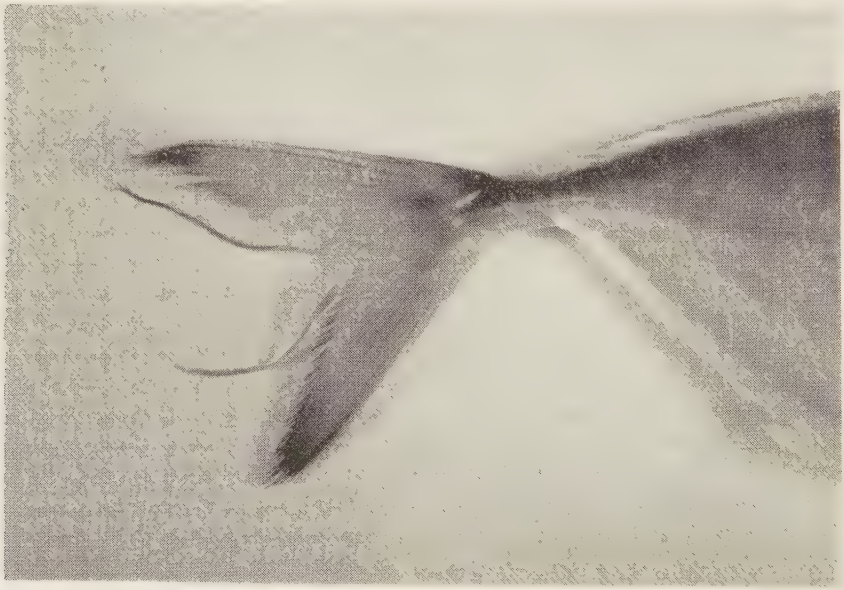
Species	General size range in millimeters*	Importance to sport fishery
ctis crinitus (African pompano)	50–150	None
anx crysos (blue runner)	50–250 (550)	Frequently taken by anglers; still fishing, trolling; also used as bait in trolling for big game fish
anx bartholomaei (yellow jack)	§	None
anx hippos (crevalle jack)	50–300	Frequently taken by anglers; still fishing, occasionally trolling offshore
apterus macarellus (mackerel scad)	35–200	None
apterus punctatus (round scad)	30–200	None
ucrates ductor (pilotfish)	50–280 (600)	Rarely taken by anglers
goplites saurus (leatherjacket)	200–280	None
ar crumenophthalmus (bigeye scad)	50–280	Infrequently taken by anglers
ene vomer (lookdown)	30–250	Rarely taken by anglers
iola dumerili (greater amberjack)†	375–650	Infrequently taken by anglers; trolling offshore
iola zonata (banded rudderfish)†	50–400	Irregularly taken by anglers; still fishing, trolling
iola fasciata (lesser amberjack)†	‡	None
achinotus carolinus (pompano)	40–250 (470)	Rarely taken by anglers
achinotus falcatus (permit)	35–225	Unknown
achurus lathami (rough scad)	45–200	None
mer setapinnis (Atlantic moonfish)	50–200	None

n fork length; figures in parentheses are local maxima.
Reported by Latham (1964) from Long Island Sound in vicinity of Orient, October 1, 1960. No details of size available.
mberjacks are usually taken by trolling offshore, and those that have been xamined have been small- to medium-sized *Seriola dumerili* or *S. zonata*. Possibly . *falcata* also occurs since it has been reported to the eastward at Woods Hole Mass.).
insburg (1952) recorded a specimen 46.6 millimeters in standard length taken o ong Island.

Table 2. Data for Blue Runners Taken at Various Long Island Locations in October 1964

Date	Length in millimeters		Method of capture	Location
	Standard	Fork		
October 2	154	163	Trawling	Great Peconic Bay
October 5	152*	161	Trawling	Little Peconic Bay
October 8	178*	185	Trawling	Noyack Bay
October 8	172	180	Trawling	Noyack Bay
October 8	177*	186	Trawling	Noyack Bay
October 8	183*	191	Trawling	Noyack Bay
October 8	185§	192	Trawling	Noyack Bay
October 8	181	190	Trawling	Noyack Bay
October 8	164§	175	Trawling	Noyack Bay
October 8	171	180	Trawling	Noyack Bay
October 8	177	185	Trawling	Noyack Bay
October 8	159*	168	Trawling	Noyack Bay
October 8	141*	151	Trawling	Noyack Bay
October 8	167	177	Trawling	Noyack Bay
October 10	..	185	Angling	Fire Island Inlet
October 10	..	182	Angling	Fire Island Inlet
October 12	..	186	Angling	Fire Island Inlet
October 12	..	197	Angling	Fire Island Inlet
October 24	200*	210	Hand net†	Great South Bay
Mean	170.7	181.3		
Range	141–200	151–210		

* Parasitized by one copepod (*Lernaeenicus longiventris*).
§ Parasitized by two copepods (*L. longiventris*).
† Fish was floundering helplessly at surface.



Parasitic copepods (*Lernaeenicus longiventris*) attached to tail of blue runner taken in Noyack Bay, Long Island, on October 8, 1964.

infrequent. In years of abundance they are an acceptable and even desirable addition to the anglers' catch and are locally known as pilotfish (a name more properly assigned to *Naucrates ductor* which is rarely seen inshore). When the banded rudderfish reaches a length of about 250 millimeters it loses its banded pattern (Ginsburg, 1952) and anglers fail to identify them or simply refer to them as jacks or amberjacks.

In offshore ocean waters, where a great deal of trolling is done for both small and large game fish, larger individuals of these species and a fourth, the greater amberjack *(Seriola dumerili),* are encountered. All four species are extremely variable in abundance, but in some years they are relatively common. Those taken in these waters may weigh up to several pounds, but, except for the larger specimens of the greater amberjack, they are generally considered "trash" fish by the sport fishermen who are seeking fish such as tuna, marlin and mako. However, the blue runner (taken either by trolling or secured from trap fishermen) is highly regarded as a whole or cut bait in trolling for the big game species.

LITERATURE CITED

American Fisheries Society. 1960. A list of common and scientific names of fishes from the United States and Canada. Spec. Pub. No. 2, Second Edition

Berry, Frederick H. 1959. Young jack crevalles (*Caranx* species) off the Southeastern Atlantic coast of the United States. U. S. Fish and Wildl. Serv., Fish. Bull. 59 (152) : 417–535.

Ginsburg, Isaac. 1952. Fishes of the family Carangidae of the northern Gulf of Mexico and three related species. Publ. Inst. Marine Sci. 2 (2) : 43–117.

Latham, Roy. 1964. Long Island fish records by Roy Latham. (unpublished list furnished by author)

McKenney, Thomas W., Elizabeth C. Alexander and Gilbert L. Voss. 1958. Early development and larval distribution of the carangid fish *Caranx crysos* (Mitchill). Bull. Mar. Sci. Gulf and Carib. 8 (2) : 167–200.

Nichols, John T., and Charles M. Breder, Jr. 1926. The marine fishes of New York and southern New England. Zoologica 9 (1) : 1–192.

Wilson, Charles B. 1917. North American parasitic copepods belonging to the Lernaeidae; with a revision of the entire family. Proc. U. S. Nat. Mus. 53:1–150.

———— 1932. The copepods of the Woods Hole region, Massachusetts. Bull. U. S. Nat. Mus. No. 158:1–635.

NOTES CONCERNING THE OCCURRENCE OF THE SNAKEFISH (*TRACHINOCEPHALUS MYOPS*) IN LONG ISLAND WATERS[1]

Irwin M. Alperin Conservation Biologist
New York State Conservation Department[2]

The snakefish (*Trachinocephalus myops*) may be added to the ichthyofauna of New York on the basis of two specimens. The one illustrated was collected at Shinnecock Bay on southeastern Long Island on October 18, 1964 in a haul seine over a sand bottom in about 1½ meters of water. It was a small specimen that measured 84 millimeters in standard length (89 millimeters in fork length). The fin ray counts were: dorsal, 13; anal, 15; pectoral, 12-12; pelvic, 8-8. The other, a previously unreported specimen (Latham, 1964), was taken at Mattituck on Peconic Bay on eastern Long Island on September 10, 1934 and measured approximately 203 millimeters (8 inches).

Although Fowler stated that the species reaches a length of 375 millimeters (Anderson *et al.*, 1966a), other specimens recorded have been smaller. Anderson *et al.* (1966a) cited one of 231 millimeters in standard length, and Norman (1935) measured a stuffed specimen of 330 millimeters in total length. According to Jordan and Evermann (1896) *T. myops* has only 11 dorsal rays, but both Norman (1935) and Gibbs (1959) reported 12 or 13, while Anderson *et al.* (1966a) recorded 11 to 13.

This species is infrequent along the Atlantic coast north of North Carolina. It was reported by Summer *et al.* (1913) to have occurred at Woods Hole (Mass.) during five different years in the late 1800's and again in 1903; these observations were made during July, September and October. Gibbs (1959) reported postlarvae in the offshore waters of the northwestern Atlantic in 1956 at 40°04′N. and 70°35′W. on September 2 and at 39°28′N. and 69°30′W. on October 30. His specimens were taken at the surface in or near the Gulf Stream, the latter over more than 1,000 fathoms. There are no other published records.

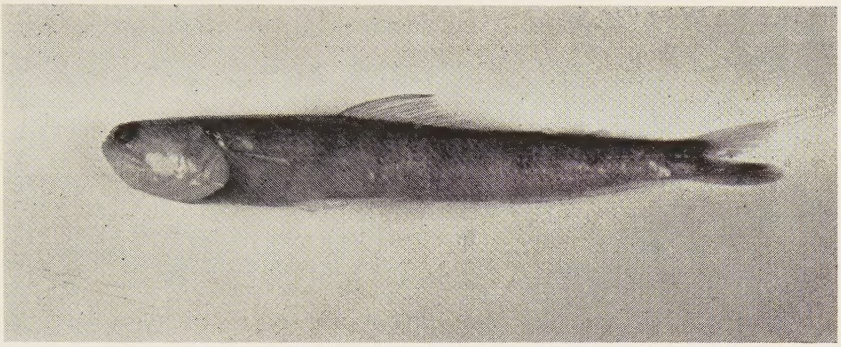
The inshore lizardfish (*Synodus foetens*) is the only other species of the family Synodontidae that is reported to reach the latitude of Long Island where it occurs from time to time in the bays at the eastern end and along the south shore that afford the sandy bottoms it prefers. Although its range in the western Atlantic, according to Jordan *et al.* (1930), extends from Brazil to Cape Cod, it is commonest along the coast of the United States from North Carolina to Florida (Anderson *et al.*, 1966a). Bean (1903) reported this species to be very common in Great South Bay on Long Island where he took 36 specimens in September and October, but Nichols and Breder (1926) considered it a straggler in southern New England and New York. Its irregular occurrence in Long Island waters was summarized by Alperin and Schaefer (1965) who found it fairly common in 1962, being present in Great South, Moriches and Shinnecock Bays from early July to early October, but absent the following year.

It seems noteworthy that both specimens of the snakefish (*T. myops*) should have been collected in years when the commoner inshore lizardfish (*S. foetens*) was unrecorded. Latham (1964) had collected lizardfish at Orient, Mattituck and Greenport (all on eastern Long Island) in 1935, 1943, 1949 and 1953, but he encountered none in 1934 when he took the snakefish. Similarly, the lizardfish was not recorded by Department personnel in dozens of seine collections at south shore and eastern Long Island stations in 1964 when the second snakefish was captured in Shinnecock Bay.

Although many early authors referred to the lizardfish as unknown to sport fishermen, Arnold (1951), reporting on its unusual abundance in southern New England in 1949, stated that three specimens, 152 to 225 millimeters in total length, had struck savagely at bait and lures. Schwartz (1960), in writing of their appearance in upper Chesapeake Bay, reported that "they strike viciously at trolled bucktails". However, Anderson *et al.* (1966a) stated that sport fishermen consider them a nuisance. They are well known, if not by their proper name, to Marine District anglers in New York, and in years when they appear in numbers they are frequently taken by sport fishermen, particularly those fishing for summer flounder (*Paralichthys dentatus*). The lizardfish is universally known as a voracious predator, and although locally it rarely reaches a length of more than 335 millimeters, it vigorously attacks the live killifish (*Fundulus heteroclitus*)

---

[1] A contribution of Federal Aid in Fish and Wildlife Restoration Project F-15-R.
[2] Present affiliation: Massachusetts Division of Marine Fisheries, Boston, Mass.



Snakefish (*Trachinocephalus myops*) taken in Shinnecock Bay, Long Island.

employed as bait in the sport fishery for summer flounder. In the summer of 1962 when the Bureau of Marine Fisheries reported that bonefish (*Albula vulpes*) had been collected in Great South Bay (Alperin and Schaefer, 1964), numerous large (250-300 millimeters) lizardfish (specimens, descriptions and photographs) were submitted for identification, chiefly by fluke fishermen who thought they had caught bonefish. Stomachs from 10 of these contained fish remains, and those that could be identified included *Menidia* sp., *Fundulus majalis, Fundulus heteroclitus, Bairdiella chrysura* and *Tautoga onitis. Menidia menidia* and *Fundulus heteroclitus* are both used as bait in the summer flounder fishery. Examination of the stomach contents of the snakefish taken in 1964 revealed only unidentifiable fish remains.

Bean (1903) reported that a small lizardfish had swallowed an entire winter flounder (*Pseudopleuronectes americanus*) which distended its stomach to more than twice its normal width. Arnold (1951) mentioned that large numbers of lizardfish were observed at Wickford Harbor, Rhode Island, feeding on silversides (*Menidia*) and small menhaden (*Brevoortia*). In addition to reporting instances of cannibalism, Anderson *et al.* (1966a) cited as food three other species (*Anchoa mitchilli, Alutera schoepfii* and *Cynoscion regalis*) that are found in Long Island waters.

Off the south Atlantic and Gulf coasts where lizardfish are abundant, they are important as forage fish and predators according to Anderson *et al.* (1966b). It seems plausible that in those summers when lizardfish are common in Long Island estuaries and bays they can be regarded as a competitive predator that may have adverse effects on the numbers of juvenile food and game fishes, as well as the forage species, that frequent these areas. On the other hand, they may make a small contribution to the sport fishery because of their aggressiveness toward bait and artificial lures.

LITERATURE CITED

ALPERIN, IRWIN M., AND RICHARD H. SCHAEFER. 1964. Juvenile bonefish (*Albula vulpes*) in Great South Bay, New York. N. Y. Fish and Game Jour. 11 (1) :1–12.

———————— 1965. Marine fishes new or uncommon to Long Island, New York. N. Y. Fish and Game Jour. 12 (1) :1–16.

ANDERSON, WILLIAM W., JACK W. GEHRINGER AND FREDERICK H. BERRY. 1966a. Family Synodontidae, lizardfishes. In: Fishes of the Western North Atlantic, No. 1, Part V. Sears Found. Marine Res., Yale Univ.:30–102.

———————— 1966b. Field Guide to the Synodontidae (lizardfishes) of the Western Atlantic Ocean. U. S. Fish and Wildl. Ser., Circular 245.

ARNOLD, EDGAR L. 1951. Northward dispersal of warm-water marine fishes in southern New England during the summer of 1949. Copeia 1951 (1) :87–88.

BEAN, TARLETON H. 1903. Catalog of the fishes of New York. N.Y.S. Mus. Bull. 60, Zool. 9.

GIBBS, ROBERT H., JR. 1959. A synopsis of the postlarvae of western Atlantic lizard-fishes (Synodontidae). Copeia 1959 (3) :232–236.

Jordan, David S., and Barton W. Evermann. 1896. The fishes of North and Middle America. Bull. U. S. Nat. Mus. No. 43, Part I.

Jordan, David S., Barton W. Evermann and Howard W. Clark. 1930. Check list of the fishes and fishlike vertebrates of North and Middle America north of the northern boundary of Venezuela and Columbia. Rep. U. S. Comm. Fish. 1928. (Appendix 10).

Latham, Roy. 1964. Long Island fish records by Roy Latham. (Unpublished list furnished by author.)

Nichols, J. T., and C. M. Breder, Jr. 1926. The marine fishes of New York and southern New England. Zoologica 9 (1) :1–192.

Norman, J. R. 1935. A revision of the lizardfishes of the genera *Synodus, Trachinocephalus* and *Surida.* Proc. Zool. Soc. London 1935:99–135.

Schwartz, Frank J. 1960. Recent additions to the Upper Chesapeake Bay fish fauna. Chesapeake Science 1 (3 & 4) :210–212.

Sumner, Francis B., Raymond C. Osburn and Leon J. Cole. 1913. A catalogue of the marine fauna. In: A Biological Survey of the Waters of Woods Hole and Vicinity. Bull. U. S. Bur. Fish. Vol. 31, Part II:549–794.

INSECTICIDES IN THE MARINE ENVIRONMENT

Jack Foehrenbach Sanitary Chemist
New York State Conservation Department

Earl Harris Senior Analytical Chemist
New York State Conservation Department

Quentin R. Bennett Marine Fisheries Sanitarian
New York State Conservation Department

Because of the current interest in insecticide residues in natural environments, it seems desirable to report certain observations made in waters along the south shore of Long Island (N. Y.) in 1965. DDT was being used for mosquito control on marshland in the vicinity of Nicoll Point on Great South Bay, and Thiodan was being used for aphid control on potato fields along Mecox Bay (Figure 1).

Samples of water, mud and shellfish were collected at intervals of several weeks from March to November (Table 1) from inshore waters adjacent to the areas where the insecticides were used. The samples from Great South Bay were taken from an area about ¼ mile from Nicoll Point, and the ones from Mecox Bay were from random points throughout the bay. From each sample, except for those collected on November 1, one liter of water, 50 grams of air-dried mud, and 50 grams of shellfish from at least 10 groundup specimens were extracted. The water samples were extracted by using a separatory funnel, and the mud and shellfish samples in a Soxhlet apparatus. The November samples were lyophilized before extraction, and therefore a much larger sample (128.9 grams of clam meat and 173.1 grams of oyster meat) was extracted.

With respect to shellfish, no residue was found in any of the samples except those collected in November for which the sensitivity was greater because of the

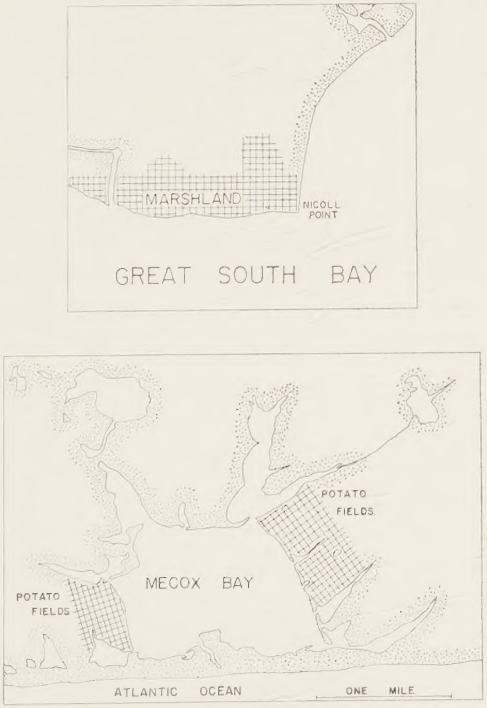


Figure 1. Relation of the areas where insecticides were used to the waters of Great South Bay and Mecox Bay.

TABLE 1. DATE, LOCALITY AND COMPOSITION OF SAMPLES COLLECTED IN 1965

Date	Locality	Composition*
March 23	Nicolls Point	water, mud, hard clams
April 16	Mecox Bay	water, mud, oysters
May 18	Nicolls Point	water, mud, hard clams
July 8	Mecox Bay	water, mud, oysters, hard clams
July 22	Nicolls Point	water, mud, hard clams
July 29	Mecox Bay	water, mud, soft clams
September 8	Mecox Bay	water, mud, oysters
November 1	Nicolls Point	hard clams, oysters

* Shellfish species were: oyster, *Crassostrea virginica*; hard clam, *Mercenaria mercenaria*; soft clam, *Mya arenaria*.

larger amount extracted. These samples contained 0.015 mg/Kg^{-1} of DDT and 0.108 mg/Kg^{-1} of DDE for the clams and 0.34 mg/Kg^{-1} of DDT and 0.07 mg/Kg^{-1} of DDE for the oysters on a wet weight basis.

Butler (1964) showed that oysters may concentrate DDT 70,000 times from the surrounding sea water. At this rate, for the concentration found in the oysters sampled in the present study, the surrounding water would have contained about 5×10^{-6} mg/Kg of DDT. This is several orders of magnitude less than the concentration which affects the shell growth of oysters; Butler (1960) reported that 0.1 mg/Kg^{-1} affected the growth of young oysters.

The marshlands around Nicoll Point had concentrations of 0.268 mg/Kg^{-1} of DDT in samples of dried mud taken early in the spring before any spraying for the 1965 season was begun. They were connected to the bay waters by mosquito-control ditches and were subject to constant exchange of water due to tidal action, winds, etc. Apparently marsh muds have a high holding capacity for DDT; they do contain a large amount of organic matter. It should also be noted that Mecox Bay was landlocked during the entire sampling period.

LITERATURE CITED

BUTLER, PHILIP A. 1962. Effects of pesticides on oysters. Proc. 1960 Nat. Shellfish. Assoc. Convention 51:23–32.

———————— 1964. Commercial fishery investigations. In: The effects of pesticides on fish and wildlife. U. S. Fish and Wildl. Ser., Circ. 226:65–77.